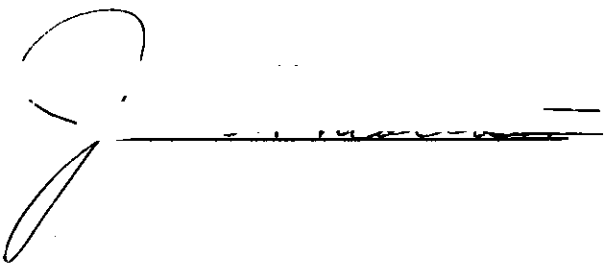
In presenting the dissertation as a partial fulfillment of the requirements for an advanced degree from the Georgia Institute of Technology, I agree that the Library of the Institute shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to copy from, or to publish from, this dissertation may be granted by the professor under whose direction it was written, or, in his absence, by the Dean of the Graduate Division when such copying or publication is solely for scholarly purposes and does not involve potential financial gain. It is understood that any copying from, or publication of, this dissertation which involves potential financial gain will not be allowed without written permission.



7/25/68

# DESIGN AND SIMULATION OF A COMPOSITE PERSONNEL SERVICES TEAM OF AN ARMY DIVISION

A THESIS

Presented to

The Faculty of the Division of Graduate

Studies and Research

by

James Herbert Macia III

In Partial Fulfillment

of the Requirement for the Degree

Master of Science in the School of

Industrial and Systems Engineering

Georgia Institute of Technology

November 1971

DESIGN AND SIMULATION OF A COMPOSITE

PERSONNEL SERVICES TEAM OF AN

ARMY DIVISION

Approved:

Chairman

Date approved by Chairman: 23 Nov 1971

# ACKNOWLEDGMENTS

I would like to thank Dr. L. G. Callahan, Associate Professor in the School of Industrial and Systems Engineering, for his time and guidance during the preparation of this thesis. I would also like to thank the other members of the reading committee, Drs. J. Gordon Davis and D. C. Montgomery, for their well appreciated assistance.

TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF ILLUSTRATIONS

## SUMMARY

The overall objectives of this research effort are to develop a quantitative methodology for the design of a composite personnel services team and to use simulation as a means to determine the effectiveness of the design methodology. This problem is of interest because the current procedure used by the Department of the Army to design these organizations is not quantitatively based on the expected workload and simulation has not been widely used in analysis of administrative organizations.

A composite team is one of seven identical elements in the Adjutant General's Section of an Army Division. These teams are assigned responsibility for a portion of the units of the division and process virtually all administrative transactions from these units. The data for this research effort were gathered from the 197th Separate Infantry Brigade at Ft. Benning, Georgia.

Once the data was gathered, it was used to determine the number of personnel required to process the expected input. The number of personnel was determined, based on the working time available to each individual worker, divided into the time required to complete all work. This procedure resulted in the basic organization. Simulation models were developed for both this designed organization and the organization currently proposed by Department of the Army. Experiments were conducted on both models testing the adequacy of each, comparing the performance

of each, and testing the designed organization under extreme loading conditions.

The results of these experiments indicated that the quantitative methodology could produce a 26 percent reduction in direct-worker personnel and an overall reduction of 35 percent in the entire organization. This methodology and the use of simulation to test the performance of administrative organizations was found to be applicable to administrative organizations with well defined procedures and those where adequate historical data is available.

# CHAPTER I

# INTRODUCTION

## Nature of the Problem

> Any attempt to understand the Army must always start--and finally return to--the individual soldier; he, in aggregate, is the Army.
>
> --General George H. Decker (18)

The Adjutant General of a division is responsible for administrative, postal, special and personnel services. He directs, controls and coordinates elements and functions which impact directly upon the morale and efficiency of each assigned member of the division, and upon the state of training and combat readiness of the division as a whole (3). Because of the key position of his section within the division, it is essential that the Adjutant General and his personnel be properly trained, motivated and equipped to do their job, and that their organization be properly designed to efficiently handle the workload that it receives from the division.

This research effort will be limited primarily to the design of the organization within the Adjutant General's (AG) section. More specifically, it will concern the design of the composite team of the Personnel Services Division (PSD) of the AG section.

There are five basic types of divisions in the US Army: infantry, armored, mechanized infantry, airmobile and airborne. These divisions vary in organization depending on the type and vary in total strength from approximately 15,000 to 18,000 men.

There are five major commands within a division, Division Artillery, three maneuver brigades, and Division Support Command (DISCOM), in addition to a number of special purpose battalions, squadrons, and companies. Figure 1 shows the organization of a typical division. Figure 2 shows the organization of the Division Support Command of which the AG Company is an element. Finally Figure 3 shows the internal organization of the AG Company. These figures are shown to give the reader an appreciation for the organization of the division and the relative position of the AG Company.

The PSD is the heart of the AG Company and performs most of those tasks which are generally considered to be administrative support of the division. It is responsible for the operation of the division personnel management program, acting on personnel services matters, furnishing statistical information as required, reporting personnel status to higher headquarters, maintenance of military personnel records, and the processing of personnel actions (2).

As Figure 3 indicates, there are four branches within the PSD. The Personnel Records Branch (PRB) has responsibility for the maintenance of military personnel records. The Personnel Management Branch (PMB) has responsibility for the maintenance of strength, promotions, and reassignments. The Personnel Actions Branch (PAD) has responsibility for processing personnel matters pertaining to individual members of the division. The Administrative Machine Branch (AMB) has responsibility for the computer support of all AG functions (2). A complete list of the functions for which each branch has responsibility will be provided in Chapter III. AMB will not be included because

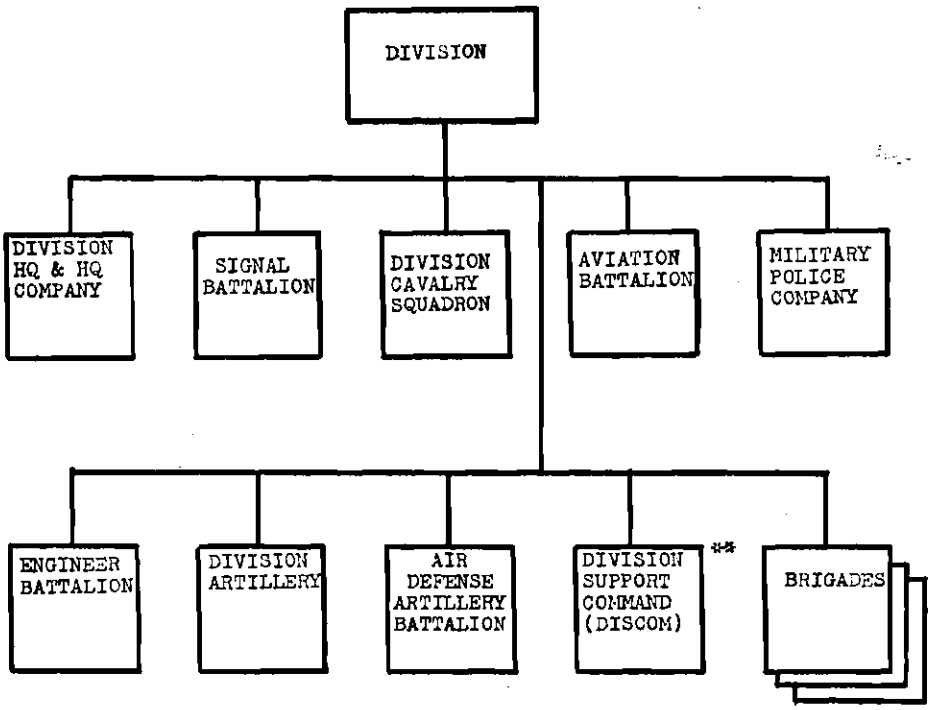



**Figure 1. Organization of an Army Division**

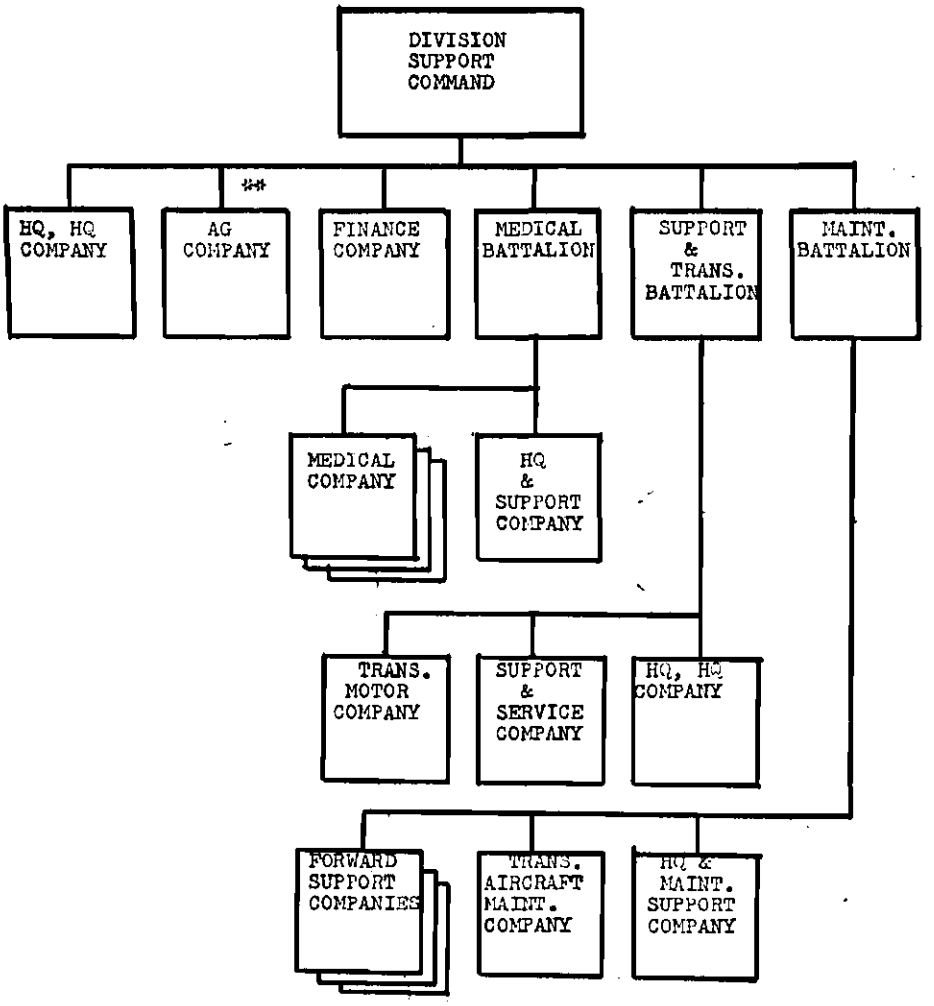



**Figure 2. Organization of Division Support Command**

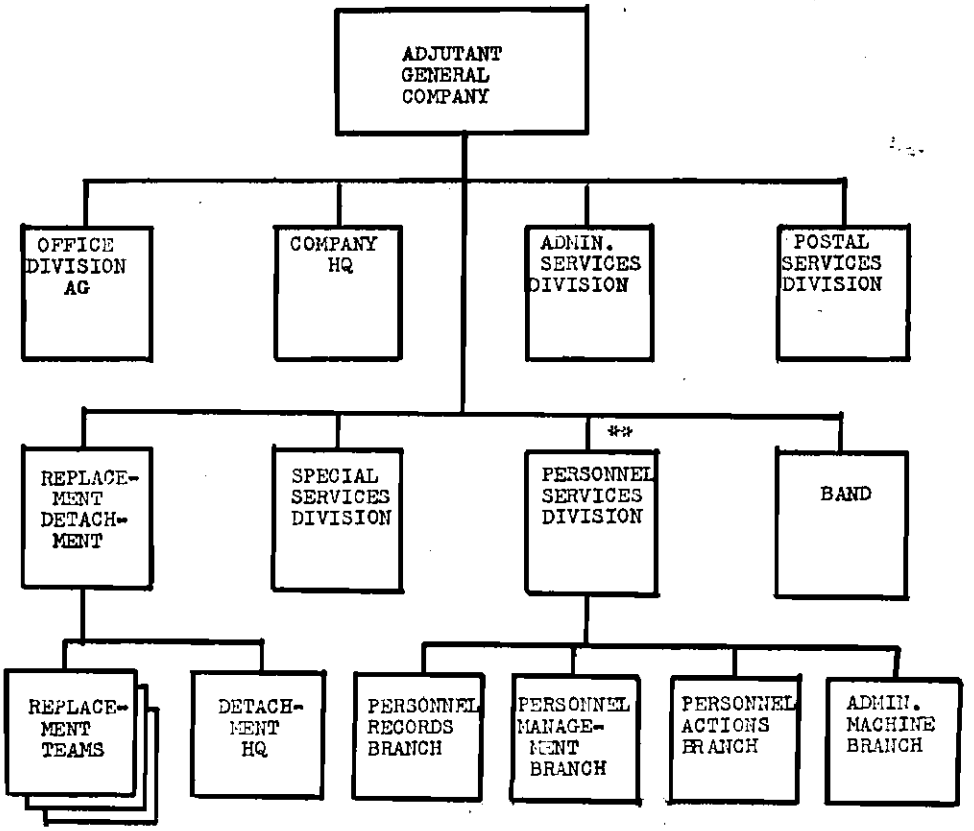



**Figure 3. Organization of Adjutant General Company**

the composite team includes only members from PRB, PMB and PAD.

A composite team is an internally organized segment of PSD at the direct-worker level. The mission of the composite team is to provide complete personnel services for specific units in a centralized configuration (3). As far as possible all composite teams should be identically manned and responsible for approximately the same number of personnel. The composite team concept is considered to be the best implementation of the Personnel Services Division resources to provide direct personnel support services to all elements of the division (3).

In Figure 4 the detailed internal organization of the PSD is shown (with the exception of AMB). Each block from the branch NCO's down represents an individual worker. Within each composite team there are the following personnel: three personnel actions specialists (PA SPEC) responsible for all personnel actions with the senior personnel actions specialist being both a supervisor and direct-worker. Two reports specialists responsible for the processing of all morning reports. One records team leader responsible for the supervision of the entire composite team. Nine personnel records specialists each responsible for the maintenance of a portion of the composite team's personnel records with the three senior records specialists having both supervisory and direct-worker responsibilities. Two processing specialists responsible for processing individuals in and out of the division. Two control specialists responsible for the maintenance of suspense items on all individuals served by the composite team. Four personnel

management specialists responsible for all personnel management matters within the composite team with the senior personnel management specialists having both supervisory and direct-worker responsibilities.

Although each composite team is a self-contained organization, the functional responsibilities and communications channels to the branch headquarters in PSD are split. Each major division of the composite team communicates directly with a corresponding element in its branch headquarters. The solid lines crossing the double line in Figure 4 show these lines of communication.

## Statement of Objectives

The purpose of this research is to develop a methodology for the design of the organization of a composite team, and to construct computer simulation models of both the designed organization and the one currently proposed by Department of the Army (Figure 4). Then these models are to be used as a basis for comparison of the new and currently proposed organizations.

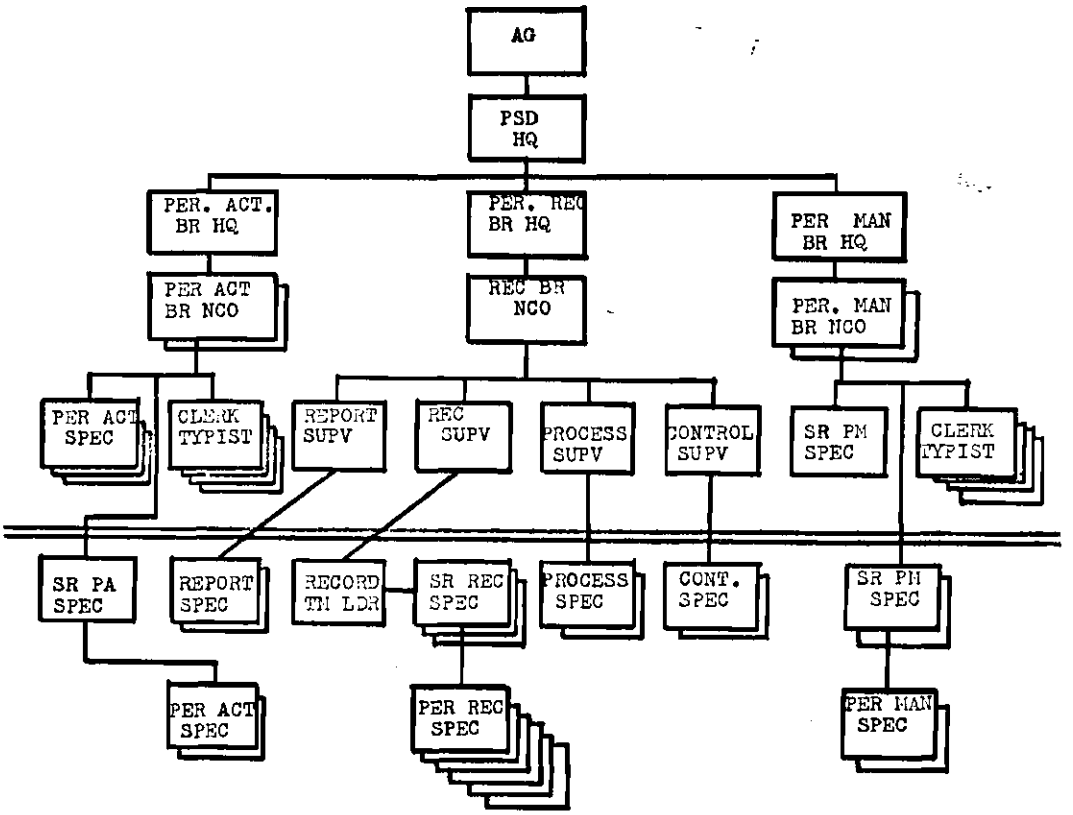
The specific objectives are:

(1) To develop a methodology for the design of the organization of a composite team, design this organization.

(2) To develop a computer simulation model of the newly designed organization.

(3) To develop a computer simulation model of the currently proposed organization.

(4) To conduct experiments on both models under varying input and examine the responses.




* Composite team is below the double line.

**Figure 4. Organization of Personnel Services Division**

In constructing the simulation model, General Purpose Systems Simulator II (GPSSII) will be used. Data will be gathered from the 197th Separate Infantry Brigade at Fort Benning, Georgia. Although the 197th Separate Infantry Brigade is a separate brigade and not a division, it is an organization of approximately 5,000 men which contains the same types of elements as a division. Therefore the input data would be the same as for a division if it contained 5,000 men instead of 15,000 men. The input data will be multiplied by a factor based on the strength of the 197th Brigade to adjust the input, be that expected from 2,200 men. There are 2,200 men served by one composite team.

Neither simulation model can be directly verified, because neither organization is currently in existence; however, both models closely conform to the physical and functional characteristics of the organizations and therefore should give a fairly accurate indication of the behavior of the organization. Naylor states that verification of models remains today as the most elusive of all unresolved problems associated with computer simulation techniques (12).

The following assumptions are made in order to achieve the stated objectives.

(1) All personnel possess average ability to accomplish assigned tasks within their military occupational specialty (MOS).

(2) Supplies and equipment (typewriters, paper, etc.) are adequate to accomplish all assigned tasks.

(3) One work week will consist of 2,000 minutes (five eight-hour days with 50 productive minutes in each hour).

(4) A division will consist of 15,000 men with each composite team serving 2,200 men (seven composite teams in a division).

## Scope and Limitations

The specific models developed in this thesis are applicable only to a composite team of the Personnel Services Division. However, the methodology for the design of the organization is applicable to any other comparable administrative organization that processes a well defined set of actions.

# CHAPTER II

## LITERATURE SEARCH

### Digital Simulation

The development of digital computers has given rise to the use of digital simulation in the study of complex systems. Many types of problems lend themselves to simulation; however, there are certain disadvantages to the use of simulation which should be noted. Simulations may require excessive amounts of computer storage and execution time; their models may require many years to build and refine, and it remains very difficult to simulate human decisions where any amount of discretionary latitude is present. The military use of simulations has been quite extensive in recent years, not only in war gaming actual military strategies, but also in modelling logistical and communications systems (8). There are mixed feelings among the military about the usefulness of simulations. Some accept simulation results without question, as a true reflection of the modelled system, while others consider the use of simulation as worthless, because of the many restrictions and assumptions that often must be made to construct the model (13, 20). The real value of any simulation is directly related to the model upon which the simulation is conducted. Therefore, the model and its builder must be evaluated along with the computer manipulation of the data. The model used for any simulation must

include all essential factors of the real world system, and accurately depict the relationships between them (1).

## Simulation Languages

There are two categories of computer languages: general purpose and special purpose. Simulation projects may be written in either. However, if a general purpose language is used, there are distinct disadvantages.

> To conduct a computer simulation model of a real world system in any general purpose, problem oriented language such as FORTRAN requires a great deal of effort. The programmer is totally responsible for all detail in the model. We have seen that this can become an arduous task. Special purpose languages were developed to eliminate the major portion of this programming effort by providing a simulation-oriented framework about which models could be constructed (14).

There are two types of special purpose simulation languages: continuous-change and discrete-change. Certain types of problems are best suited for each, although some problems lend themselves to the use of either (15).

A continuous-change language would be appropriate when the system to be studied consists of a continuous flow of materials, information, etc. which are considered in aggregate rather than individually. The resulting models are usually in the form of differential equations which describe the rate of change of the systems over time. This type of model has been used in social science, economics and military dynamics (8, 14, 19).

The discrete-change languages, on the other hand, are oriented toward individual transactions. The systems are modelled in networks with each individual component possessing finite capabilities. The

languages incorporate the use of queuing theory and stochastic processes. In the past, discrete-change languages have been applied to job shops, communications networks, traffic systems and military logistical systems. General Purpose Systems Simulation II (GPSS II) is such a discrete-change language (14). It lends itself to scheduling and waiting line problems (12).

GPSS II is a second generation language, its predecessor being GPSS 360. The language itself is represented by blocks which can be readily inserted into a block diagram depicting the flow of transactions through the model. Each type of block has a unique programming format which transmits appropriate instructions to the computer. Once the block diagram has been constructed within the rules of the language, the program is virtually complete (14, 16).

## Applications of Simulation to Administrative Systems

A thorough search of the literature revealed no instance where simulation had been applied to an administrative system. The reason for this may be that traditionally administrative systems have been considered too diversified to lend themselves to precise measurement and analysis (9).

## Office Management

Because the problem at hand is, in many ways, the design of an office, literature in this field was investigated. Most references were in agreement on all major aspects of the design, layout, work measurement, and environmental considerations of the office. Attempts

have been made to quantify work standards for clerical personnel, but most of these efforts have been oriented toward the economic considerations of defining a fair day's work. Little, if any, consideration has been given to estimating the expected input under varying conditions and the clerical staff's ability to cope with the situation. A great deal of discussion is devoted to environmental considerations such as lighting, noise, rest breaks, etc. (9, 10, 11).

The number of clerical workers in the United States has increased six times more rapidly than the total work force in the last century. Yet, in many ways the office is and has always been thought of as a more or less non-productive part of any organization, necessitated by the requirement to keep at least a minimal amount of records. As organizations have become more complex and the requirement for records more extensive and important, this non-productive element of the organization has become so large and expensive, that it can no longer be ignored. Some of the newer, more analytical methods must be applied to it as they have been applied in other fields (9).

Development of Tables of Organization and Equipment

The procedure for the management of tables of organization and equipment (TOE) is specified in Army Regulation (AR) 310-31 (8). It specifies the staffing procedures for the development of all TOE's. In essence, when a TOE is formulated, the complete organizational structure and equipment are specified, based on the organization's mission. At the present time the TOE for an AG Company is formulated

in the following manner. The Assistant Chief of Staff for Force Development specifies in AR 570-2 the ratios of clerical direct-worker personnel to the number of personnel supported. The current ratios are:

| | |
|---|---|
| Personnel Records | 1 direct-worker per 242 |
| Personnel Actions | 1 direct-worker per 714 |
| Personnel Management | 1 direct-worker per 577 (6) |

These latest ratios were arrived at by canvassing the ten active divisions during the period September 1964 through March 1966 to determine how many personnel each division was then utilizing in the various branches of PSD. From this survey the current ratios were evolved. It was assumed that each division was operating efficiently and no consideration was given to the amount of work to be accomplished, who would do it, and how long it would take (17).

Once the ratios have been established, the requirement for the new TOE is passed to the Combat Developments Command for the actual formulation of the TOE. In the case of the AG Company, the responsibility falls to the Personnel and Administration Services Agency, Fort Benjamin Harrison, Indiana, which is a component of the Combat Developments Command. These ratios are then directly applied to arrive at the manning levels for the AG Company. Once the TOE has been formulated by the Combat Developments Command, it is then staffed through Department of the Army and adopted (5).

## Adjutant General Operations

The operations conducted by the AG and his section are specified in FM 12-4 and DA Pamphlet 600-8 (3, 7). FM 12-4 gives

general guidance on organizational layout and mission, while DA Pamphlet 600-8 gives detailed procedural instructions on the handling of virtually every personnel matter that can occur. In addition to these two references, each type of personnel transaction has one or more pertinent Army Regulations covering the criteria for decisions on the particular matter in question. These regulations are important to the individual practitioner in making his decisions, but are not important in this study.

The criteria for judging the effectiveness of AG operations by the Inspector General are outlined in TB IG 2 (4). This reference gives the inspecting officer very general and highly subjective guidance. There are no quantitative criteria for measurement of the effectiveness of AG operations.

# CHAPTER III

# DESIGN OF THE SYSTEM

## General

The approach to the design of an organization for a composite team of a division AG is rather simple and straightforward. Data was gathered from the 197th Separate Infantry Brigade. This data was of two distinct types. First, the frequency of each type of transaction was determined; secondly, the action time for each type of transaction was determined. Where possible, the frequency of each type of transaction was determined by tabulation of file copies for the 18-month period from 1 January 1970 through 30 June 1971. These frequencies were then adjusted to the strength of the Brigade in order to approximate input from 2,200 men. By using weekly input figures adjusted to the strength each month, it was possible to maintain the seasonal fluctuations which occur in some transactions. In the case of the action time, it was determined by observation of personnel actually completing the task or where this was not possible, by interview and comparison with other similar transactions for which hard data was available. The source of data for all types of transactions is listed later in the chapter.

Once the data were collected, it was determined that most of the action times fell into one of six ranges: $5 \pm 2$ min., $10 \pm 2$ min., $15 \pm 2$ min., $30 \pm 5$ min., $40 \pm 10$ min., and $240 \pm 60$ min. Transactions that did not fall into these ranges were individually assigned action

times based on the data. The types of transactions were then grouped according to what branch of PSD has responsibility for handling them based on DA Pam 600-8. The action time was then multiplied by the expected frequency per week for each month during the 18-month period. All products for each month within a particular branch were then summed and divided by 2,000 (the number of minutes available to a clerk each week). This gave a basic figure for determining the number of clerks required to complete the work. This figure was then used to formulate the organization along with some subjective judgements to insure continuity within the organization. Once the organization has been formulated, it is necessary to simulate its activity over a period of time because some types of transactions occur only periodically and were averaged to arrive at the above sum.

## Detailed Formulation

### Personnel Management

Table 1 shows those transactions which are processed by personnel management and the source of the data for each type. Appendix A contains complete personnel management data. Figure 5 is a graph showing the average weekly totals each month of the time required to complete all personnel management transactions. The lower line indicates the totals if all transactions require the average amount of action time, while the upper line indicates the totals if all actions require the upper limit of the range of the action time. From Figure 5 it is obvious that a minimum of two clerks is required at all times, with three clerks being

Table 1. Personnel Management Transactions.

| Number | Name | Action Time/Source | Frequency Source |
|---|---|---|---|
| 3 | Special Assignments | 30±5/Observed | Files |
| 4 | On the Job Training | 10±2/Observed | Files |
| 5 | Request for Special School | 30±5/Observed | Files |
| 8 | Nuclear Assignments | 30±5/Estimated | Files |
| 9 | Classification Retest | 15±2/Estimated | Files |
| 10 | MOS Test | 2 days/Estimated | Monthly |
| 11 | Request for Warrant Officer Flight School | 30±5/Observed | Files |
| 12 | Request for Language Aptitude Test | 10±2/Estimated | Files |
| 13 | Request for Language Proficiency Test | 10±2/Estimated | Files |
| 14 | Reclassification | 15±2/Observed | Files |
| 15 | Overseas Levy | 240±60/Observed | Files |
| 16 | Assignments and Reassignments | 5±2/Observed | Files |
| 17 | Temporary Deferment from Overseas Assignment | 15±2/Observed | Files |
| 18 | Concurrent Travel | 10±2/Observed | Files |
| 21 | Requisitions for Enlisted Personnel | 3 days/Observed | Monthly |
| 22 | Enlisted Promotions | 240±60/Observed | Monthly |
| 23 | Personnel Information Roster | 5±2/Observed | Estimated |
| 25 | Volunteer for Overseas Assignment | 10±2/Observed | Files |
| 20 | MOS Inventory | 240±60/Observed | Daily |

*Numbers indicate the identifying number assigned to each type of transaction in the computer simulation.

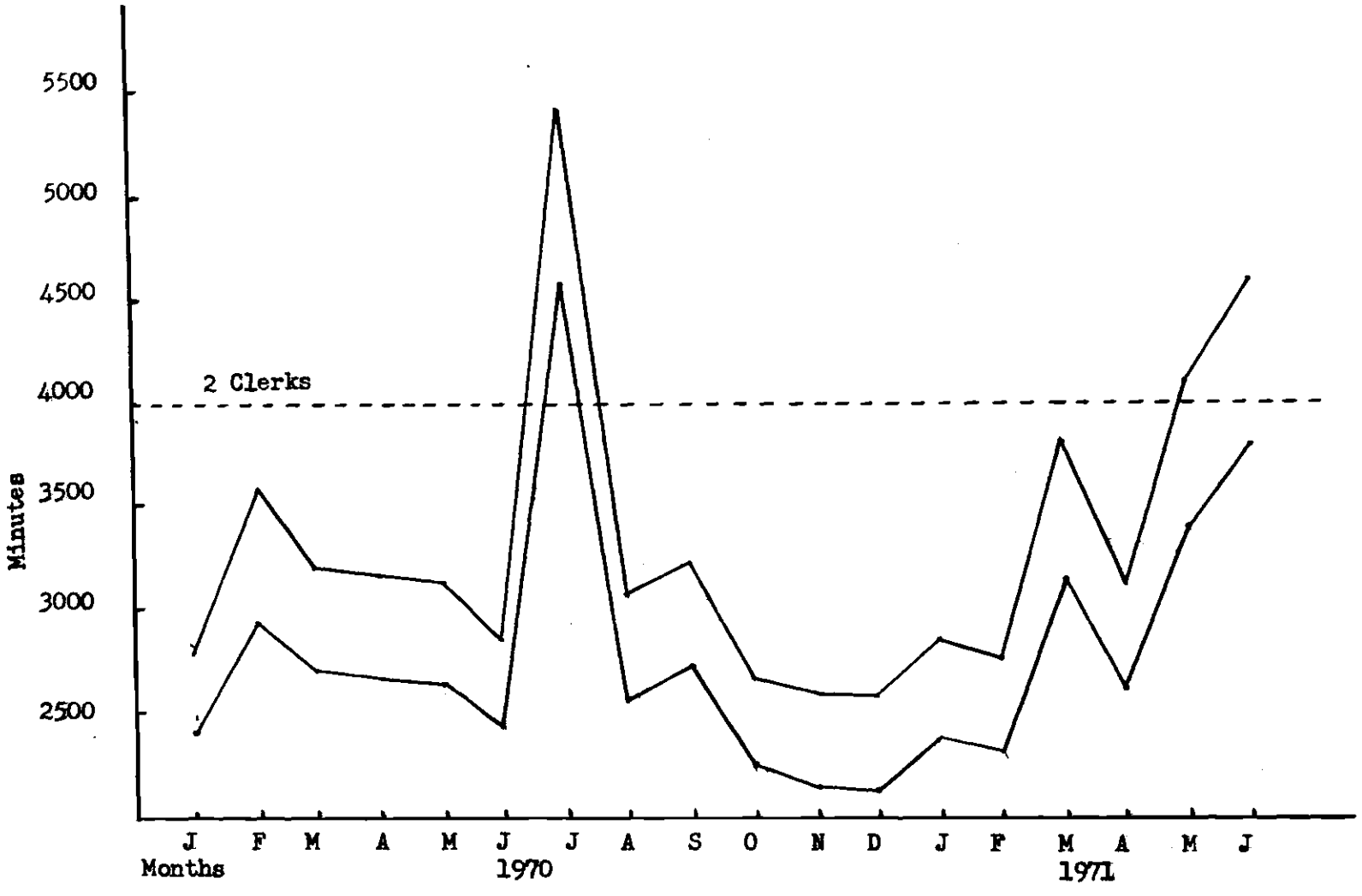



Figure 5. Personnel Management Time Requirements

required for three months at maximum action time and one month at average action time. In each month that required more than two clerks, there was a drastic increase in the number of levies which require 240 $\pm$ 60 minutes to process. If these levies had remained in their normal range of from two to three per week, two clerks would have been adequate at all times.

As a result of this analysis, it was determined that three personnel would be necessary in the personnel management branch of the composite team. Two of these personnel would be personnel management specialists, responsible for all types of routine work, while the third would be a senior personnel management specialist responsible for supervision and review of the work of the other two, in addition to accomplishing a portion of the routine work. The additional clerk provides supervision and a backup capability in the event of the absence of one clerk.

Personnel Actions

Table 2 shows those transactions which are processed by the personnel actions branch and the source of the data for each type. Appendix A contains complete personnel actions data. Figure 6 is a graph showing the average weekly totals each month, of the time required to complete all personnel actions transactions. Again, the lower and upper lines indicate the average and upper limit of the action times. In all cases except two at the upper time limit, one clerk is adequate to complete all assigned tasks. An examination of the data for the high months revealed that Discharge and Re-enlistments and Discharges for Unsuitability requiring 40 $\pm$ 10 minutes

Table 2. Personnel Actions Transactions

| Number | Name | Action Time/Source | Frequency Source |
|---|---|---|---|
| 32 | Discharge & Reenlistment | 40±10/Observed | Files |
| 33 | Change of Name, Birthdate, etc. | 10±2/Estimated | Files |
| 34 | Flagging Action | 10±2/Observed | Estimated |
| 35 | Discharge for Unsuitability | 240±60/Observed | Files |
| 36 | Request for Officer Candidate School | 30±5/Observed | Files |
| 37 | Request for Hardship Discharge | 40±10/Observed | Files |
| 38 | Request for Retirement | 30±5/Observed | Files |
| 39 | Discharge for Misconduct | 240±60/Observed | Files |
| 40 | Request for Excess Leave | 15±2/Observed | Files |
| 41 | Issuance of ID Card | 10±2/Observed | Files |
| 44 | Request for Discharge to Attend School | 15±2/Observed | Files |
| 45 | Request for Discharge for Seasonal Employment | 15±2/Observed | Files |
| 46 | Dishonored Checks | 5±2/Observed | Files |
| 47 | Request for Compassionate Reassignment | 40±10/Observed | Files |
| 48 | Request for Leave Outside of CONUS | 5±2/Observed | Files |
| 49 | Request for Separation Outside of CONUS | 10±2/Observed | Files |

*Numbers indicate the identifying number assigned to each type of transaction in the computer simulation.

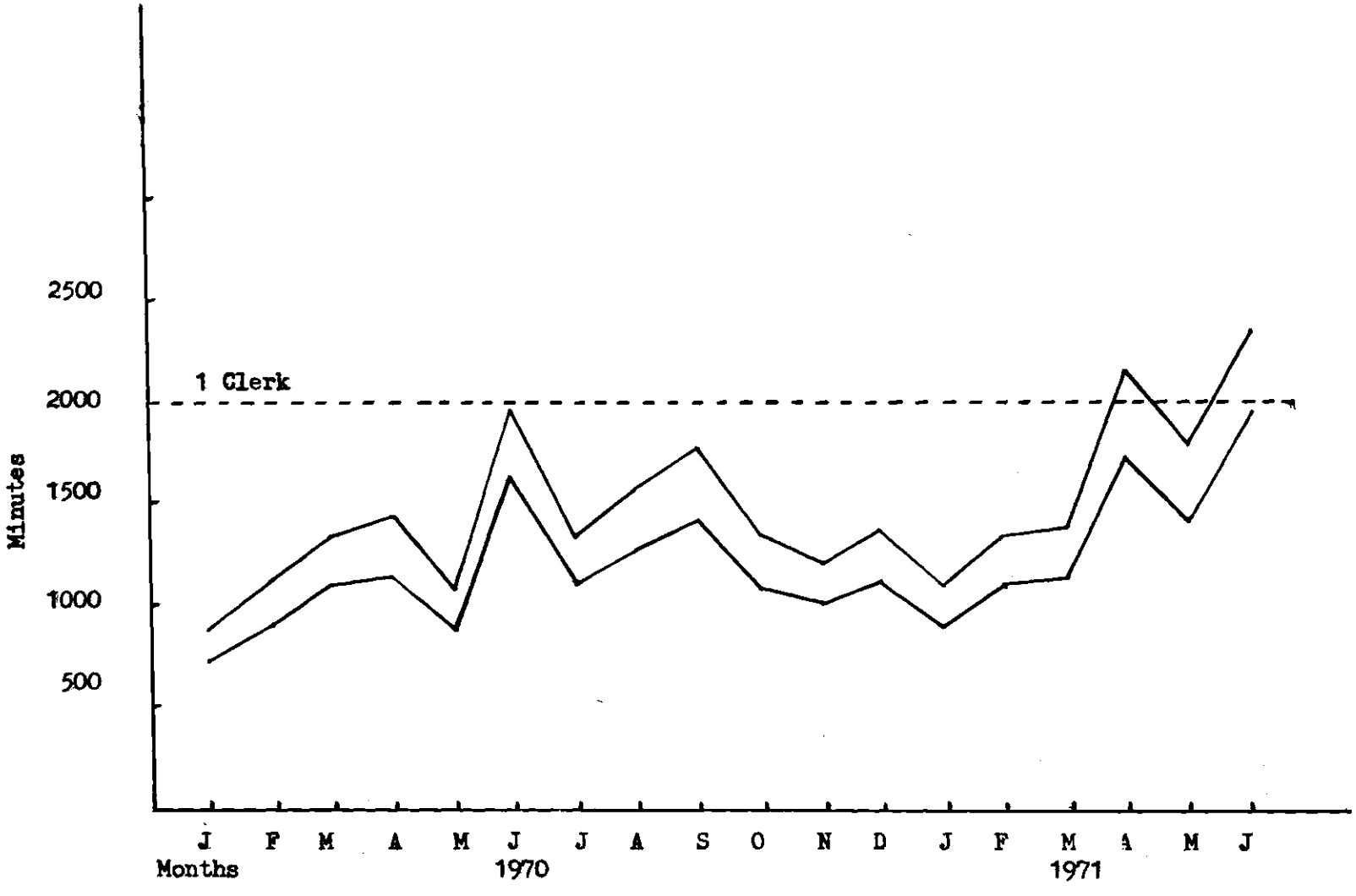



**Figure 6. Personnel Actions Time Requirements**

and 240 $\pm$ 60 minutes respectively were the cause of the peaks.

It was determined that two personnel would be necessary in the personnel actions branch. One would be a personnel actions specialist, responsible for routine work, while the other would be a senior personnel actions specialist, responsible for supervision and review of the work, in addition to a portion of the routine work. Again, as with personnel management, the additional clerk provides supervision and backup. In this case, it would be unwise to have only one individual processing all personnel actions. If he were absent, no actions would be processed.

Personnel Records

Table 3 shows those transactions which are processed by the records branch. Note that the records branch files copies of transactions processed by other branches, and also provides personnel records to other branches for processing certain types of transactions. Appendix A contains complete personnel records data.

The determination of the personnel requirements for this branch cannot be accomplished in the same manner as those for personnel management and personnel actions. This is because certain types of transactions require that all members of the records branch work on them. In addition to this requirement, their action times are directly dependent on the number of records for which each clerk has responsibility. Because of this peculiarity, those types of transactions which require the services of all personnel will be examined first. Then, the random daily trans-

actions which can be processed by one clerk, will be added to this figure to determine the expected work load for each individual clerk.

Additional problems were experienced in the data which was collected for records branch. A major responsibility of a personnel records specialist is the maintenance of the records which includes periodic reviews of the contents and condition of the records, elimination of outdated material and replacement or repair of damaged material. In addition to this, he must post material which results from other transactions. Unfortunately, data was not available on the action time required to accomplish maintenance because the records branch of the 197th Separate Infantry Brigade was simply not doing this. Additionally, the action times for those types of transactions directly dependent upon the number of records are based on each clerk maintaining 400-500 records.

Figure 7 graphically shows the time requirements for the records branch. The bottom two lines show the time requirements for those types of transactions which require processing by all members of records branch. Note that these transactions require between 1,000 and 2,000 minutes per week for each clerk. Since this data is based on 400-500 records per clerk and the composite team has responsibility for approximately 2,200, four clerks appear to be necessary in records branch. At this point, the random daily time requirements were adjusted to four clerks and these time requirements were then added for each clerk. These total time requirements are shown on the top two lines of Figure 7. In all except two months, four personnel clerks can accommodate the workload.

Table 3. Personnel Records Transactions

| Number | Name | Action Time/Source | Frequency Source |
|---|---|---|---|
| 3 | Special Assignments | 5±2/Observed | Files |
| 4 | On the Job Training | 5±2/Observed | Files |
| 5 | Request for Special School | 5±2/Observed | Files |
| 9 | Classification Retest | 5±2/Observed | Files |
| 10 | MOS Test | 5±2/Observed | Monthly |
| 11 | Request for Warrant Officer Flight School | 5±2/Observed | Files |
| 12 | Request for Language Aptitude Test | 5±2/Observed | Files |
| 13 | Request for Language Proficiency Test | 5±2/Observed | Files |
| 14 | Reclassification | 5±2/Observed | Files |
| 15 | Overseas Levy | 15±2/Observed | Files |
| 32 | Discharge & Reenlistment | 5±2/Observed | Files |
| 33 | Change of Name, Birthdate etc. | 5±2/Observed | Files |
| 34 | Flagging Action | 5±2/Observed | Estimated |
| 35 | Discharge for Unsuitability | 5±2/Observed | Files |
| 36 | Request for Officer Candidate School | 5±2/Observed | Files |
| 37 | Request for Hardship Discharge | 5±2/Observed | Files |
| 38 | Request for Retirement | 5±2/Observed | Files |
| 39 | Discharge for Misconduct | 5±2/Observed | Files |
| 40 | Request for Excess Leave | 5±2/Observed | Files |
| 44 | Request for Discharge to Attend School | 5±2/Observed | Files |
| 45 | Request for Discharge for Seasonal Employment | 5±2/Observed | Files |
| 47 | Request for Compassionate Reassignment | 5±2/Observed | Files |
| 48 | Request for Leave Outside of CONUS | 5±2/Observed | Files |
| 49 | Request for Separation Outside of CONUS | 5±2/Observed | Files |
| 52 | Verification of Personnel Rosters | 2 days/Observed | Monthly |
| 53 | Surveys | 240±60/Observed | Estimated |
| 54 | Preparation of Record of Previous Convictions | 40±10/Observed | Estimated |
| 62 | In & Out Processing | 5±2/Observed | Files |

*Numbers indicate the identifying number assigned to each type of transaction in the computer simulation.

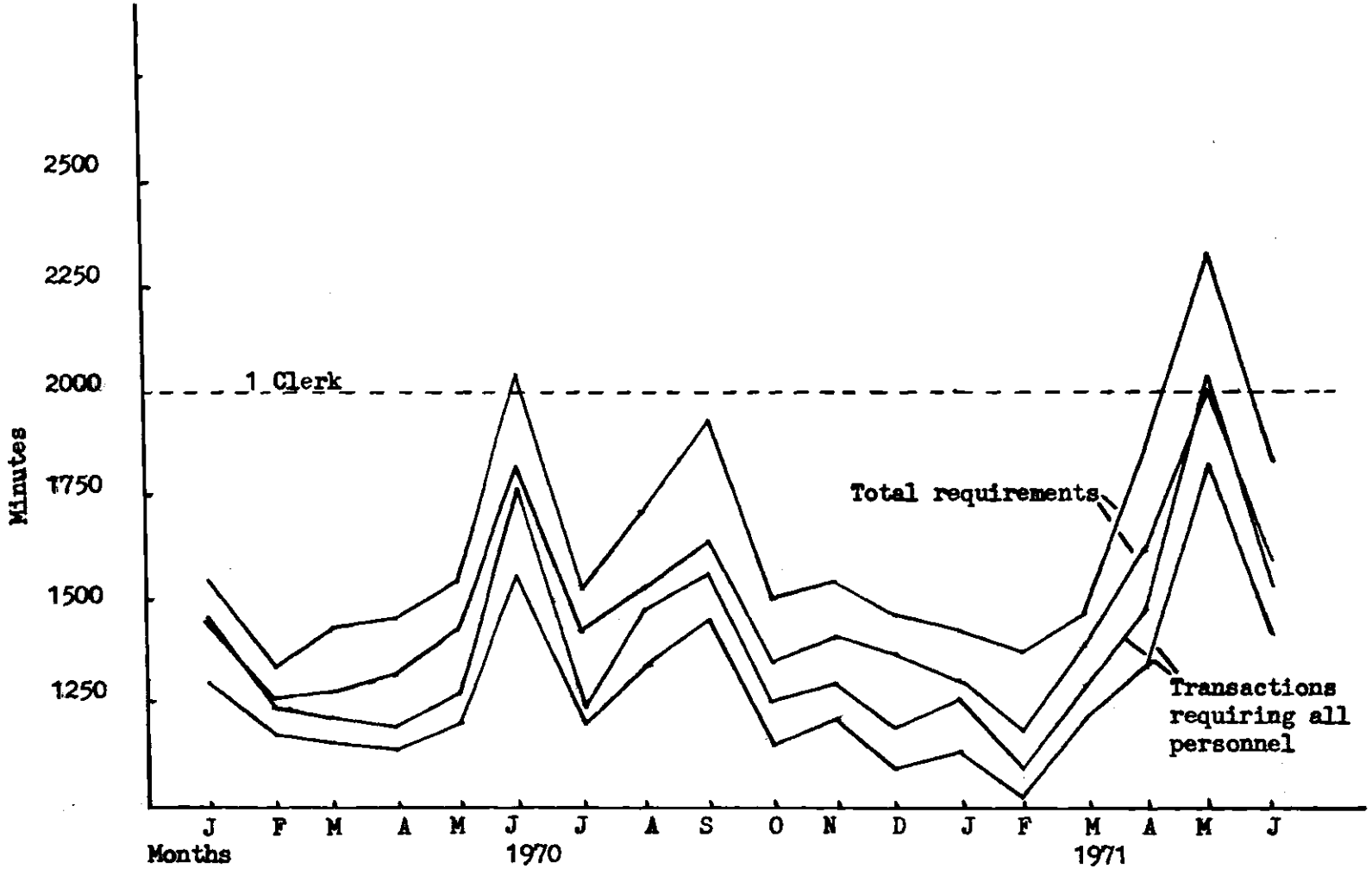



Figure 7. Personnel Records Time Requirements

From this analysis, four personnel were determined to be sufficient for the records branch. This analysis was conducted on the first week of each month when the peak time requirements for all personnel exists. During the other weeks of the month, the requirements are less by 800 minutes per records specialist and thus allow for the maintenance of records.

In addition, one NCO will be assigned to the records branch with supervisory responsibility not only for records branch, but also for the entire composite team.

Control Specialist

The control specialist is a member of records branch whose primary responsibility is notifying units and individual members of the command of various types of actions that are coming due. Examples of these are immunizations, periodic medical examinations, end of term of service, etc. There is little, if any, interaction between him and the other members of the composite team since he corresponds directly with the units served and keeps his own files. From observations at the 197th AG, it was determined that because of the uniqueness of the job, its importance and the amount of work to be accomplished, one suspense clerk was necessary. In this case the need for backup capability is not as important as with the other branches, because the work can be projected in advance and the periodic absence of the clerk will not be a detriment to the operation of the composite team. The suspense clerk will not be included in the simulations.

Reports Specialist

The reports specialist has responsibility for the daily processing of the morning reports of all companies served by the composite team. The morning report is the official daily strength accounting record of the U. S. Army. Again, as in the case of the control specialist, the reports specialists are members of the records branch and interact with other members of the composite team, only slightly. It was found that the processing of the morning reports takes two men approximately three to five hours daily, depending on the number of entries on individual morning reports. It was determined that a minimum of two personnel would be necessary. Backup capability in the event of the absence of one clerk is mandatory. One facility will be used to simulate both reports specialists. Also, the fact that they are available for other tasks each afternoon lends flexibility to the composite team to meet crises.

Processing Specialist

The processing specialist is responsible for the in and out processing of personnel assigned to the units served by the composite team. He is responsible only for in and out processing which are two types of transactions that are essentially the same. For the purposes of this study, they will be considered the same. Figure 8 is a graph showing the average weekly totals each month of the time required to complete all processing of personnel. Again the lower and upper lines indicate the average and upper limit of the action time respectively. At the average level two clerks are adequate to complete all processing

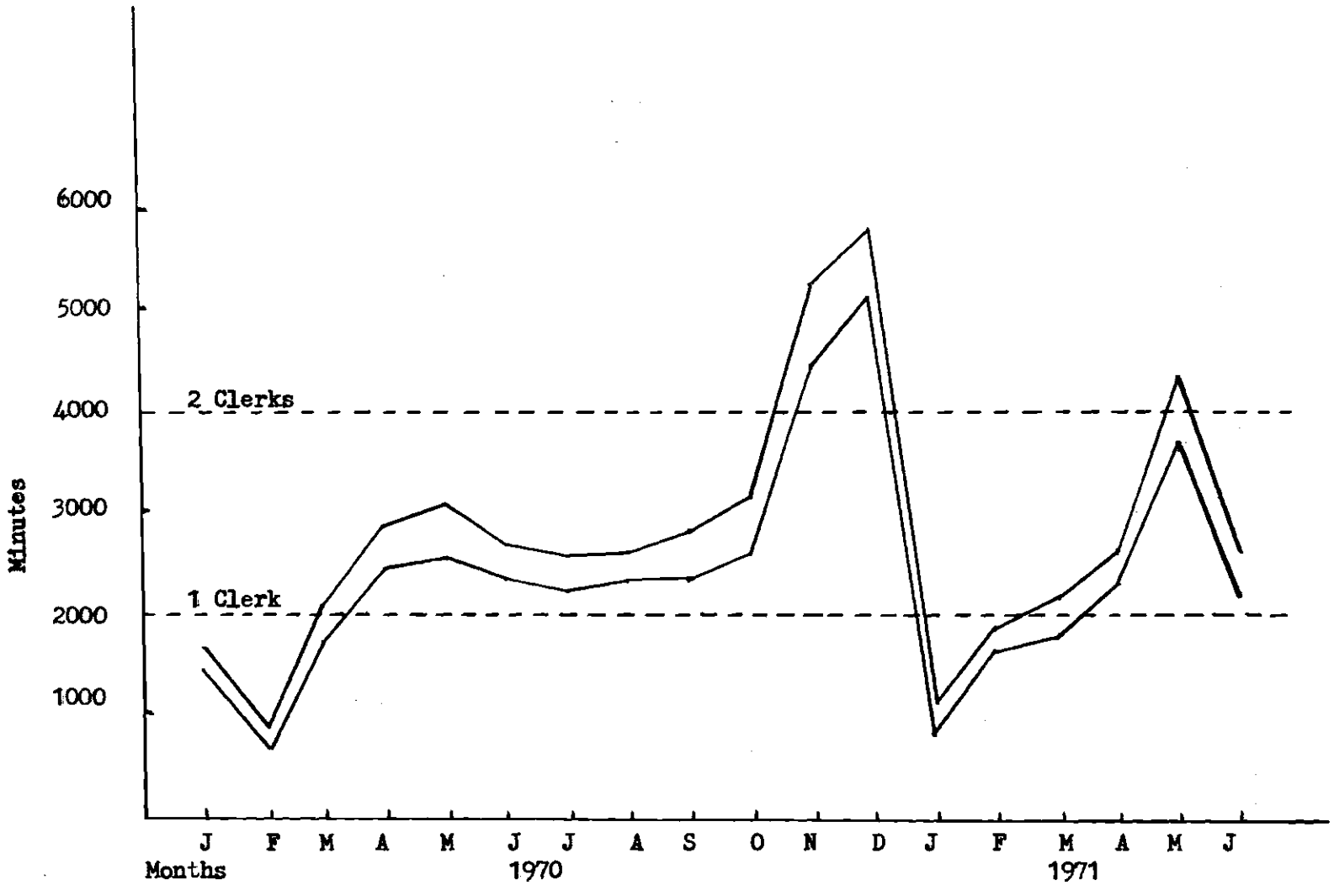
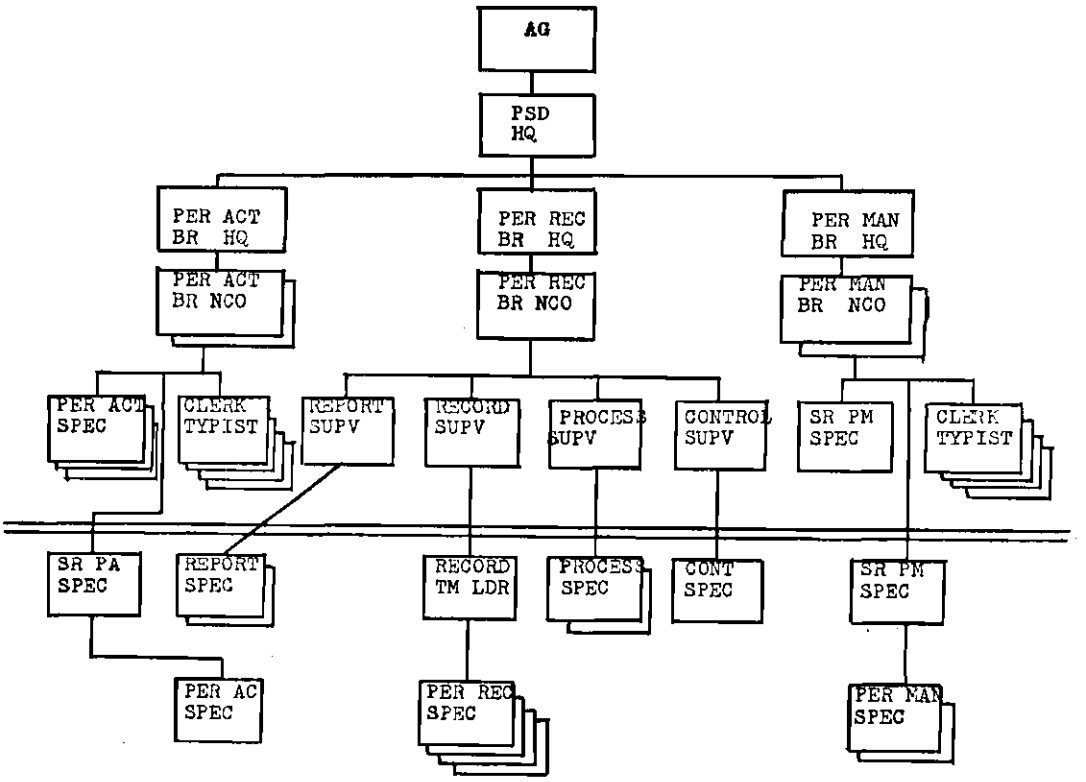



Figure 8. Processing Time Requirements

in 16 of 18 months, and at the upper limit, two are adequate 15 of 18 months. Therefore two clerks will be used in processing.

The question arises concerning the months when more than two clerks will be necessary. When peak periods of processing are experienced, special processing teams should be formed from all of the composite teams to meet the situation (3). It is the responsibility of the Adjutant General to keep abreast of the situation and form these special teams as they are needed. Additionally, because processing is not as specialized as the other branches of the composite team, other members of the composite team may readily be used to supplement the two processing specialists.




* Composite team is below the double line.

**Figure 9. Final Organization**

Table 4. Comparison of Organizations

| | D A Organization | Designed Organization |
|---|---|---|
| Senior Personnel Action Specialist | * 1 | 1 |
| Personnel Action Specialist | * 2 | 1 |
| Total Personnel Actions | 3 | 2 |
| Reports Specialist | * 2 | 2 |
| Record Team Leader | 1 | 1 |
| Senior Records Specialist | 3 | 0 |
| Personnel Records Specialist | * 6 | 4 |
| Total Records | 10 | 5 |
| Processing Specialists | * 2 | 2 |
| Controls Specialist | * 2 | 1 |
| Senior Personnel Management Specialist | * 2 | 1 |
| Personnel Management Specialist | * 2 | 2 |
| Total Personnel Management | 4 | 3 |
| Total | 23 | 15 |

* Direct-workers

Table 4 shows a comparison of the number of personnel in each organization.

# CHAPTER IV

# DEVELOPMENT OF SIMULATION MODELS

## General

Two computer simulation models will be developed. The first will depict the organization currently proposed by Department of the Army (Figure 4). The second will depict the organization developed in Chapter III (Figure 9). For the purposes of presentation in this paper, each model will be represented in a simplified block diagram with only selected portions of the GPSS II block diagram shown. This will be accompanied by the computer print-out of the compilation of the program showing all blocks.

Both models include only direct-worker personnel in the personnel management, personnel actions and personnel records branches of the composite team. The controls specialist will not be simulated for the reasons mentioned in Chapter III. In all cases except the reports specialists, each individual direct-worker will be represented by a single facility. The two reports specialists will be represented by a single facility for the two reasons mentioned in Chapter III.

Data will be generated for both programs by the same two subroutines. The parameters of each transaction will be used to identify the type of transaction, assign various action times and routing instructions. Changes in input data will be achieved by changing the characteristics of the various transaction generators

and input functions of the program. Examination of the arrival patterns of transactions at the 197th AG revealed that only the monthly and daily transactions had a consistent arrival pattern. All others arrived randomly throughout the day.

## Generation of Input Data

Two subroutines will be used to generate the transactions for both simulation models. The first generator will be used in experiments one and three. It generates transactions based on the clock time as the simulation is running, and immediately lets the transaction enter the simulation model. This subroutine has the disadvantage of requiring random numbers during the actual running of the simulation. Therefore, it does not produce exactly the same transactions for both simulation models. It has the advantage of not overloading the system with more than 1,000 transactions at any one time; therefore, it can be used to run the simulation for any length of time. The second subroutine generates all transactions at the beginning of the simulation, stores them, and lets them into the system at the correct time. This subroutine has the advantage of not being effected by the main system, and can provide identical input to both simulation models. It has the disadvantage of allowing the system to run for only one simulated month without having more than 1,000 transactions in the system at one time. The second subroutine will be used to generate transactions for experiment 2.

Both subroutines assign parameters in the same manner. Data for all types of transactions that do not occur on a regular basis (monthly or daily) was divided into groups based on the observed

action time of the type of transaction. See Appendix A. The sum of the weekly average of the occurrences in a group was then calculated for each month. This figure was then divided into 2,000 (number of working minutes in a week) to determine the mean time between each arrival from that group. This method has the disadvantage of equally spacing the transactions from a group; however, it is felt to be adequate since no arrival pattern was observed, and since each group contains transactions destined for different branches of the composite team. A ten percent variance from the mean is used to offset the regular pattern. From this information, the characteristics of the GPSS II transaction generators were determined. Next the percentage of each type of transaction within a group was calculated for each month. From these percentages functions were developed to select the identifying number of the transaction. This number is then placed in parameter one. Next, each transaction is assigned an action time, also based on a function, allowing equal probability of requiring a certain amount of action time within a particular interval. The action time is then placed in parameter three. Then, through a series of compare blocks, checking the identity of the transaction, other parameters are assigned as needed. Below is a complete list of the parameters and their use.

| Parameter | Use |
|---|---|
| 1 | Identity of type of transaction. |
| 2 | Holding time to get personnel record. |
| 3 | Holding time to process transaction. |
| 4 | Holding time to process transaction upon return, if applicable. |

| | |
|---|---|
| 6 | Holding time of transaction outside of of the composite team prior to return. |
| 7 | Holding time prior to release into system from generating subroutine 2. |

The daily monthly transactions are generated in a similar manner with the mean times between transactions being 400 and 8,000 minutes respectively. Again, the various parameters are assigned values according to the type of transaction.

Once all pertinent parameters have been assigned to a transaction, it is either sent directly into the main portion of the simulation model or stored to be sent into the model at the proper time, depending on which subroutine is used.

A computer compilation of the subroutine which generates the transactions while the simulation is running is shown with both programs in Appendices B and C. The subroutine which generates all transactions prior to the beginning of the actual running of the simulation is shown in Appendix D. The GPSS II block diagrams for records clerk (facilities 6, 7, 8, 9) reports specialist (facility 10) and process specialist (facilities 11, 12) are the same in both programs.

## Example of a Typical Transaction

Assume that a transaction is introduced into the simulation model for the new system. Assume that block 20 generates a transaction. This transaction goes to block 22 where parameter one is assigned bases on function two. Assume 18 is assigned, identifying this transaction as Request for Concurrent Travel. The transaction then goes to block 24 where an action time is assigned to parameter

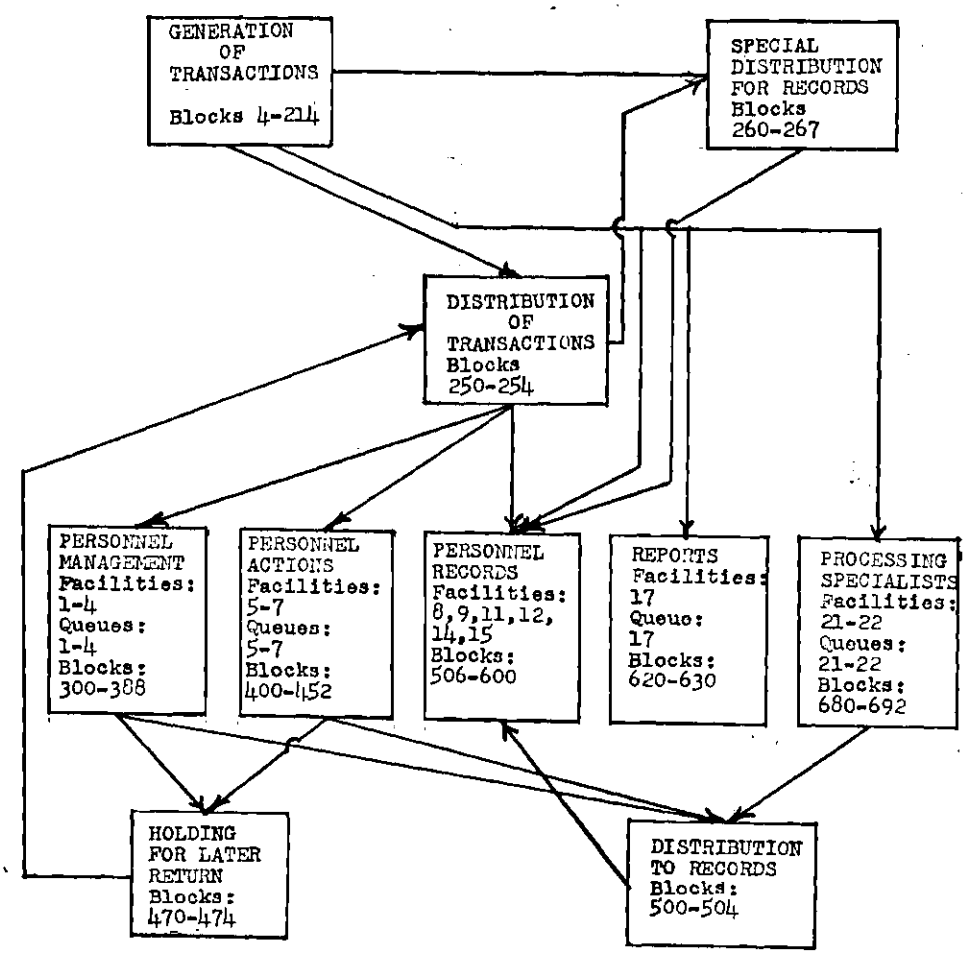



**Figure 10. Simulation Model of Department of the Army Organization**

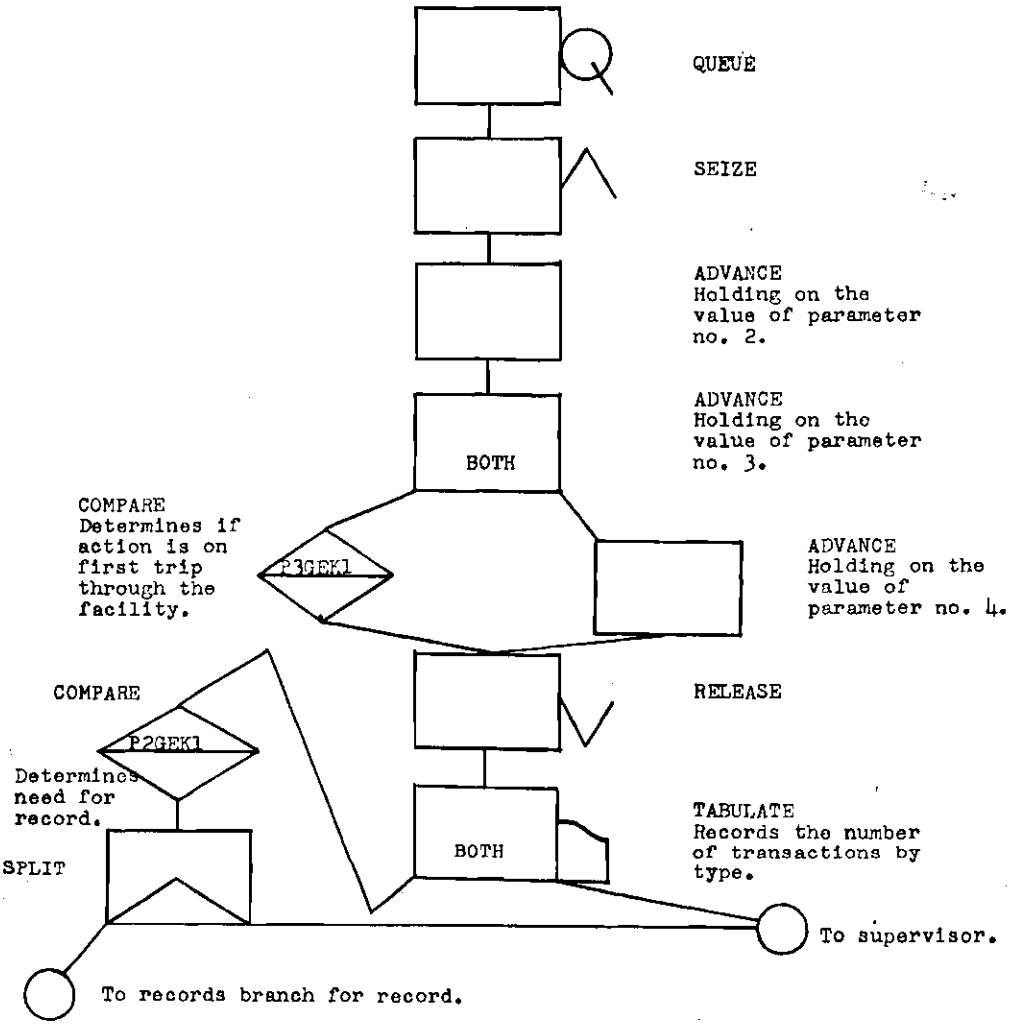



**Figure 11. GPSS II Block Diagram of Personnel Management Specialist and Personnel Actions Specialist**

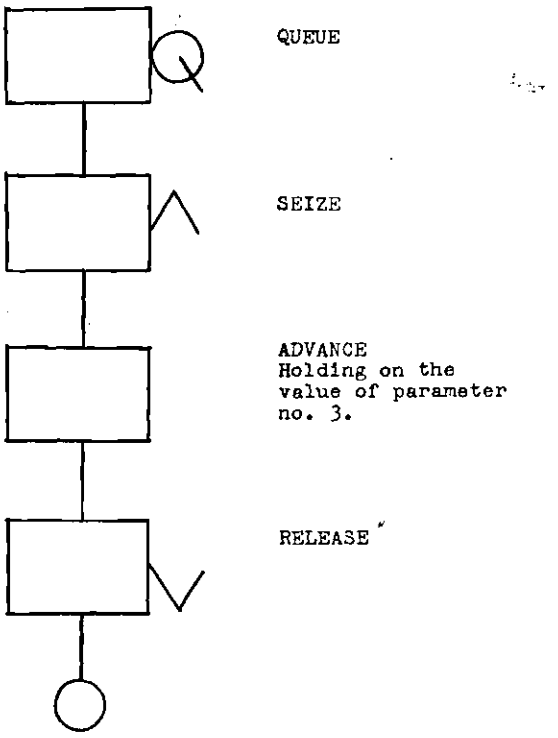



**Figure 12. GPSS II Block Diagram of Senior Personnel Management Specialist, Senior Personnel Actions Specialist, Reports Specialist, and Processing Specialist**

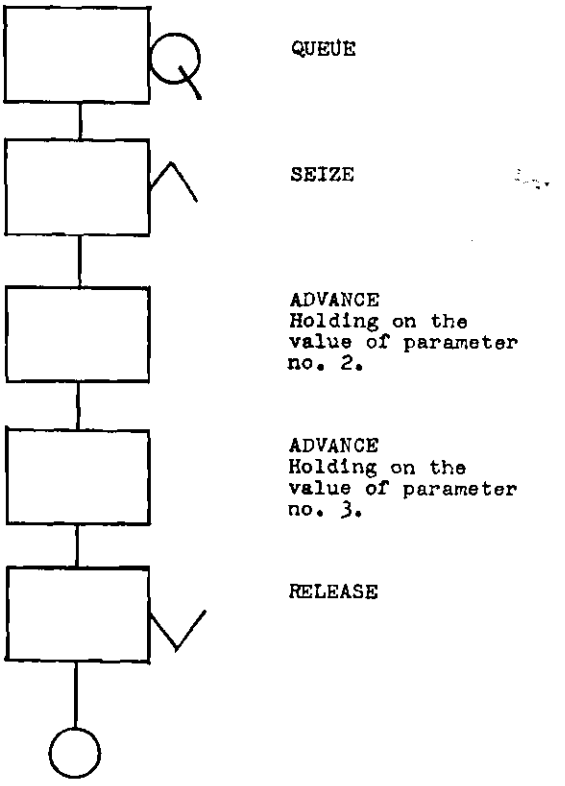



**Figure 13. GPSS II Block Diagram of Personnel Records Specialist**

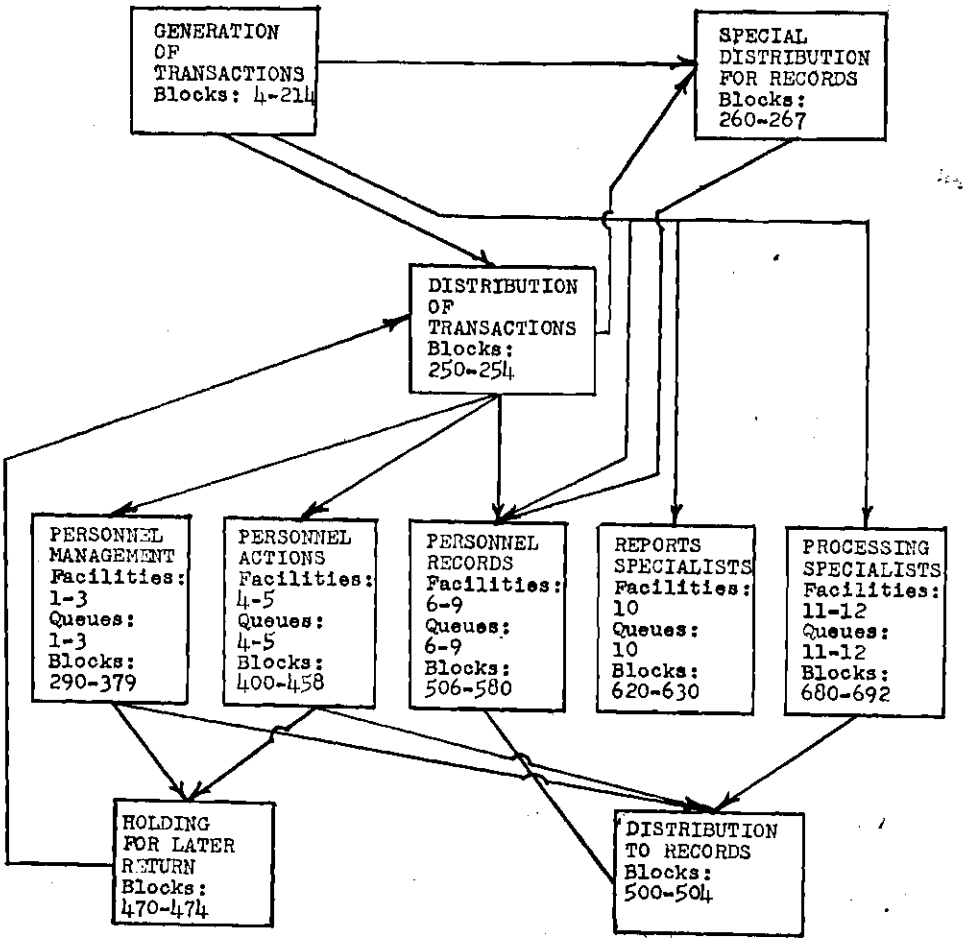



**Figure 14. Simulation Model of New Organization**

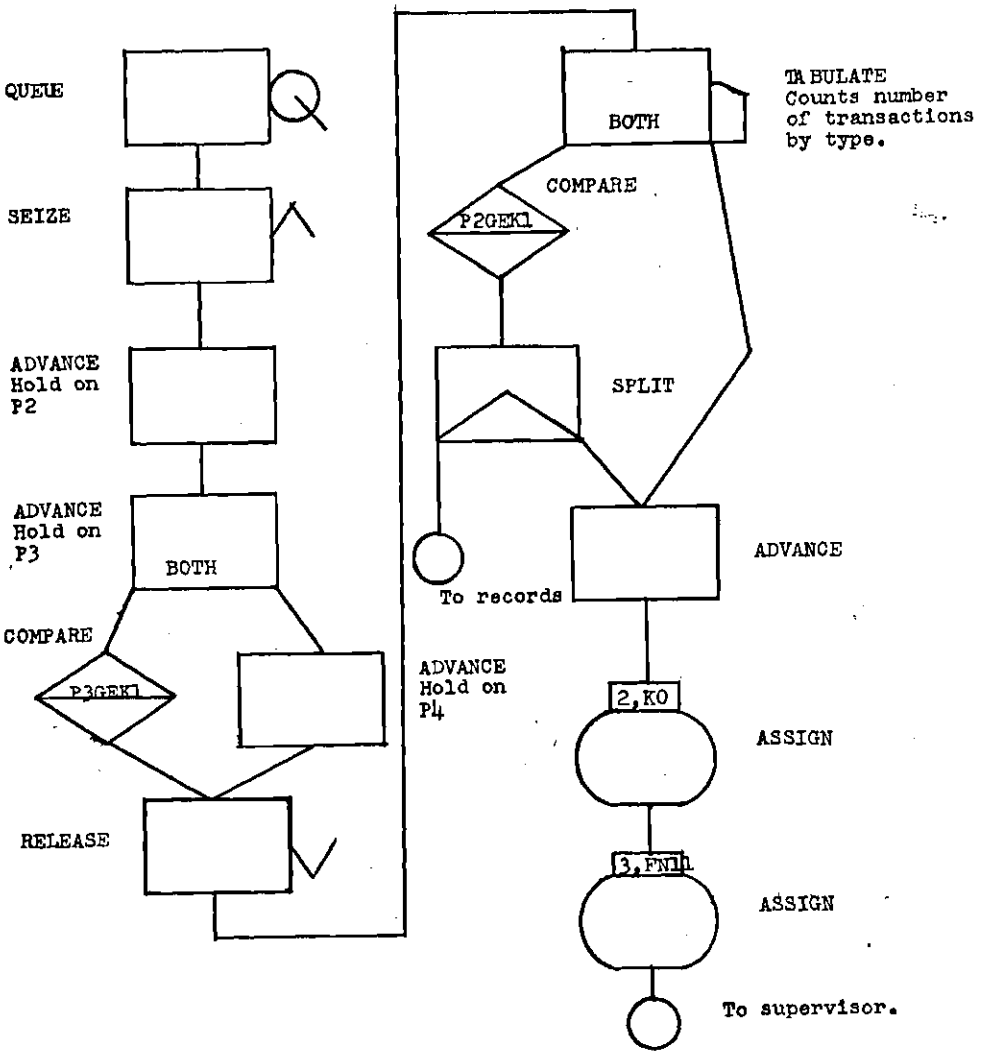



**Figure 15. GPSS II Block Diagram of Personnel Management Specialist and Personnel Actions Specialist**

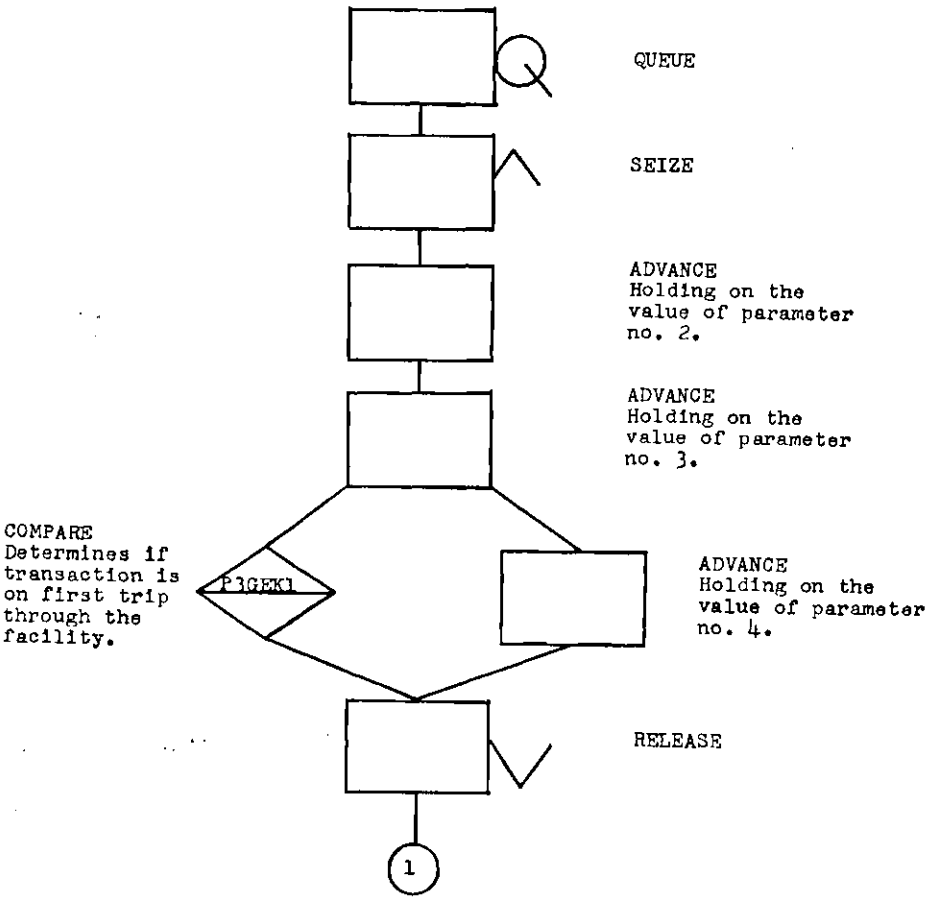



**Figure 16a. GPSS II Block Diagram of Senior Personnel Management Specialist and Senior Personnel Actions Specialist**

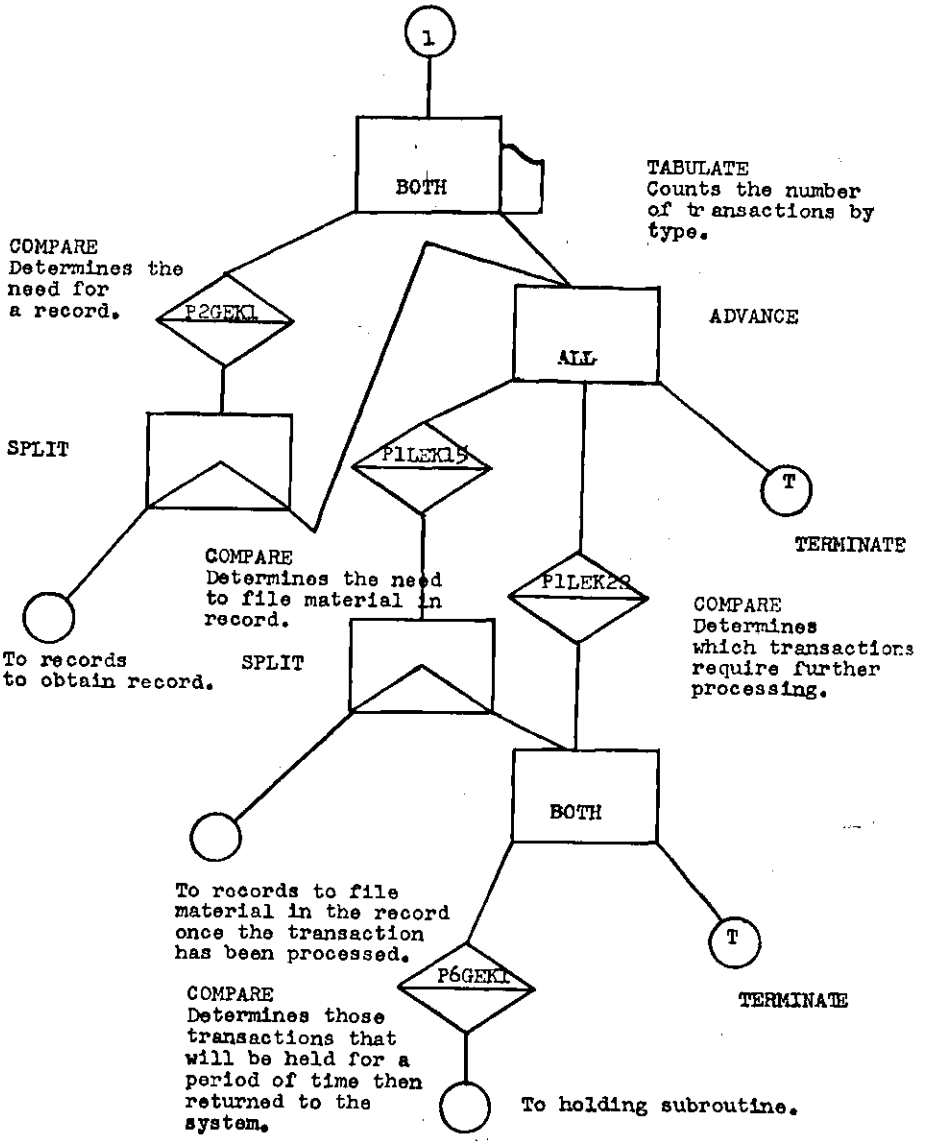



**Figure 16b. GPSS II Block Diagram of Senior Personnel Management Specialist and Senior Personnel Actions Specialist**

three, based on function 12. The transaction is then allowed to enter block 26 which is a COMPARE BLOCK accepting all transactions whose parameter one is less than or equal to 18. Next, the transaction is assigned an action time to parameter four, based on function 12, because transactions with numbers less than or equal to 18 return to the composite team after a period of time. This simulates getting approval from a higher headquarters for concurrent travel. Next, parameter six is assigned, based on function 21, This determines the length of time that transaction will be held before it is allowed to return. This simulates the length of time it takes to receive an answer from a higher headquarters. Next, parameter two is set to a constant of one minute, because a personnel record is required to complete this type of action. At this point, all pertinent parameters have been set for this type of transaction. Assume that the values of the parameters are as follows:

| P1 | P2 | P3 | P4 | P6 |
|---|---|---|---|---|
| 18 | 1 | 9 | 11 | 10,400 |

The transaction is then sent to the distribution portion of the program where it is determined by a series of COMPARE BLOCKS checking parameter one, to require processing by personnel management. It is sent to personnel management where it is assigned to one of the specialists for processing. It has an 80 percent probability of being processed by one of the two personnel management specialists and a 20 percent probability of being processed as a routine transaction by the senior personnel management specialist. Assume that it is processed by one of the personnel management specialists (Figure 15).

First, it enters his queue (in-box); once it works its way to the front of the queue, it seizes the facility. When the personnel management specialist begins work on the Request for Concurrent Travel, the first thing he must do is obtain the individual's record. This is simulated by having the transaction held in on ADVANCE BLOCK for the time indicated in parameter two; in this case, one minute. Next, the transaction goes to another ADVANCE BLOCK where the transaction is delayed, based on the value of parameter three, in this case, nine minutes. This simulates the main processing of this type of transaction. Next, a COMPARE BLOCK is used to determine if the transaction is on its initial trip through the facility. If so, it now goes to a RELEASE BLOCK. The personnel management specialist has completed all processing that he must do. Next, the transaction is tabulated in a table by type of transaction, i. e. the value of parameter one. Next, the transaction is split, with one transaction going to records branch to simulate the obtaining of the record and the other to a series of assign blocks to reset parameters. Note here that the simulation actually notifies records branch after the transaction has been processed. This is not what actually happens since the record is necessary before the start of processing; however, it was found that the records specialist is not interrupted when a record is obtained. In most cases the personnel management specialist would merely get the record himself.

The transaction now goes to the senior personnel management specialist. The parameters are now:

| P1 | P2 | P3 | P4 | P6 |
|---|---|---|---|---|
| 18 | 0 | 5 | 11 | 10,400 |

It follows exactly the same sequence through the blocks of the senior personnel management specialist until it passes the TABULATE BLOCK. This time, through a series of COMPARE BLOCKS, the record is returned to records branch for filing and the transaction is sent to the sub-routine of the program which delays it, based on parameter six.

Once it has been delayed, the appropriate amount of time, the parameters are again reset. They are now:

| P1 | P2 | P3 | P4 | P6 |
|---|---|---|---|---|
| 18 | 0 | 0 | 11 | 0 |

This prevents the transaction from cycling in the simulation model. The transaction is then redistributed as a new transaction. It again is determined to require personnel management processing and is assigned to one of the personnel management specialists. This time, however, it will be delayed only based on the value of parameter four; again, it will be sent to the senior personnel management specialist. However, this time, when it leaves him it will terminate.

All transactions are processed by the models in a similar manner. This example showed a case where the transaction required all possible types of processing. There are several other types of transactions which also require everything; however, many do not.

# CHAPTER V

# EXPERIMENTATION

## General

Three experiments will be conducted on the simulation models. The objectives of these three experiments are as follows:

(1) To determine the ability of the two organizations to accommodate the workload.

(2) To determine the designed organization's relative performance with respect to the organization currently proposed by the Department of the Army.

(3) To determine the designed organization's performance under extreme loading conditions.

The criteria for judging the performance of the organizations are as follows:

The organization can accommodate the workload if no facility is fully utilized at all times, and the average wait for those transactions which were delayed is less than one-half day (200 minutes). The relative performance of the two organizations will be judged on a comparison of the facility utilization and a comparison of the average wait of those transactions which were delayed.

Since neither organization is currently in existence in the Army, neither can be directly validated. However, since both models closely conform to the procedural and physical characteristics of the actual system, their responses are felt to be representative

of the responses of the actual systems. Additionally, a validation would take at least one year to accomplish in order to adequately analyze the seasonal fluctuations in the responses. This type of effort would be beyond the scope and resources of this research even if the organizations were in existence.

The basic approach in the experimentation will be to establish the organization currently proposed by the Department of the Army as the organization representing the current state of the art in the design of this type of organization. Experiment one will be used to establish the basic ability of both organizations to accommodate the workload that confronts the composite team. No comparison of the responses of the two organizations can be made in experiment one because the input is not exactly the same for each model. Experiment two compares the responses of each organization when exactly the same input data is used for both models, and this is the key experiment. Experiment three examines the responses of the designed organization under extreme loading.

The performance of each organization will be divided into the following elements:

Personnel Management

Personnel Actions

Personnel Records

Reports

Processing

In each case the mean performance of the element will be evaluated. In the case of the designed organization, a weighted mean will be

used since all direct-workers do not process an equal proportion of the transactions. This procedure is considered justifiable because in an actual organization of this nature, the supervisor would tend to assign work in such a manner as to equalize the workload.

As was discussed in Chapter IV, special subroutines were designed to simulate the input of transactions into the organizations. This procedure differs from more traditional simulation techniques where samples of the actual input are taken, then distributions are developed and used in the simulation as the basis for input of transactions into the model. This more traditional procedure was not used because of the requirement to assign values to several defining parameters for each type of transaction, and the fact that in most cases, data on every transaction was available for an 18 month period.

For the purposes of identification, the Department of the Army organization (Figure 4) will be referred to as Organization No. 1, while the organization designed in this paper (Figure 9) will be referred to as Organization No. 2.

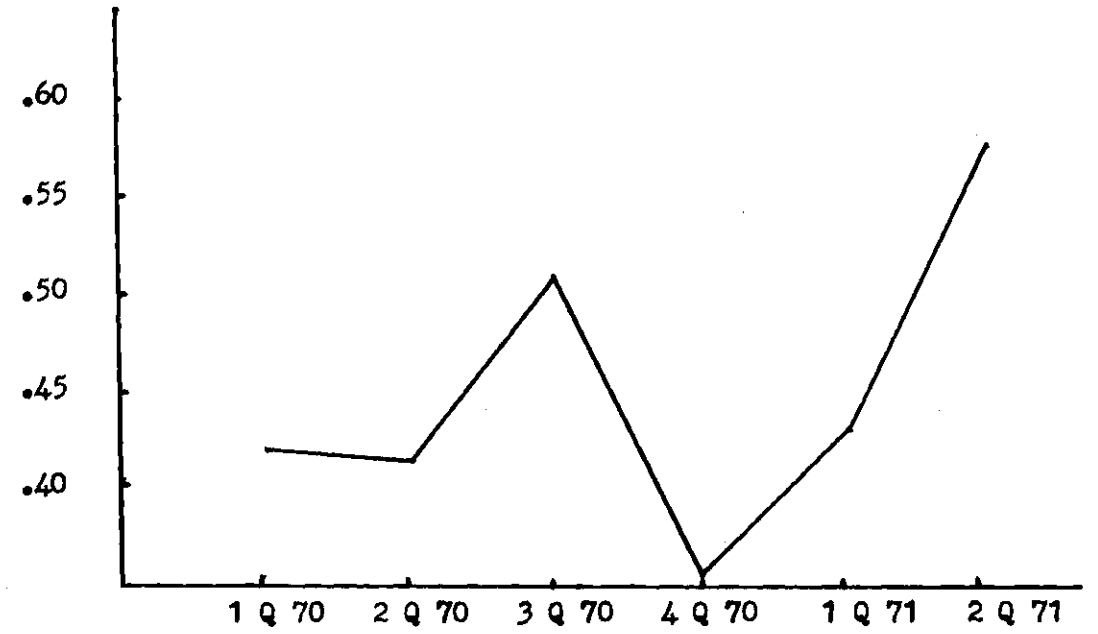
## Experiment 1

The objective of experiment number one is to determine the basic ability of each organization to accommodate the workload. Quarterly means were used for the input data and all types of transactions in Table 1, 2, 3 were initially used. The simulation was run for six weeks (1,200 minutes) which was sufficient time for all types of transactions to enter and effect the system. The

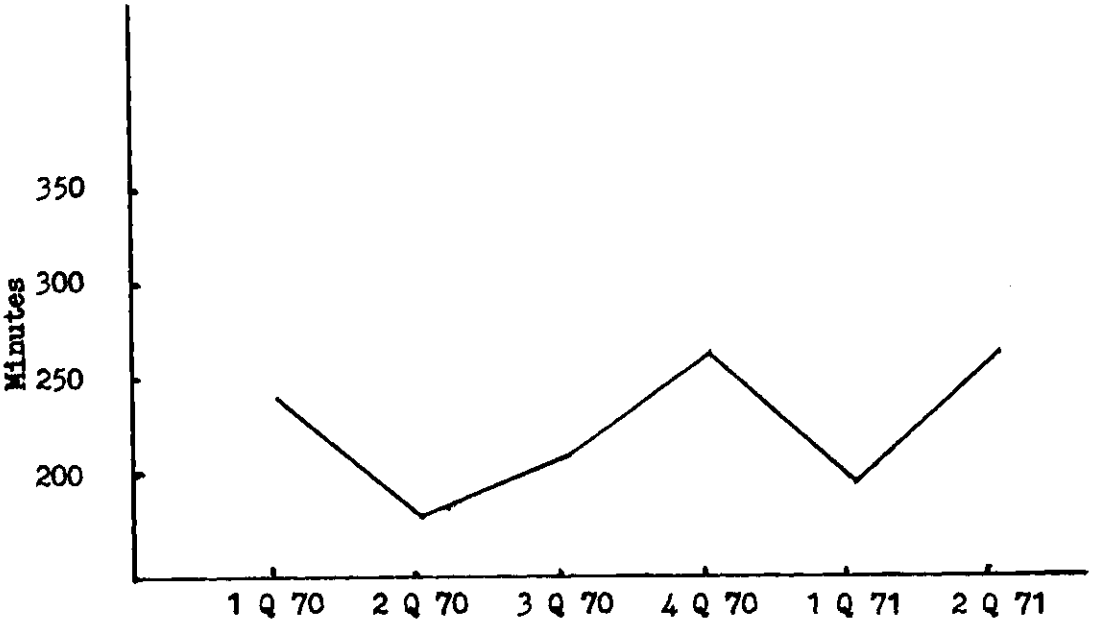
results are shown both graphically and in tabular form for each element of the organizations.

Figures 17 through 21 and Table 5 show the response of organization one to the input data. Figures 22 through 26 and Table 6 show the response of organization two to the input data. No direct comparison of the responses of the two organization can be made in this experiment because the input data is not exactly the same. Both organizations should be compared to the standards listed at the beginning of this chapter.

Note that in both organizations, both personnel management and records did not meet the standards for queue delay of less than 200 minutes (Figures 17, 19, 22, 24). In fact, in the case of personnel records, delays of over two days were experienced. An examination of the types of transactions and the expected action times involved indicated that these long delays may have been caused by transactions which occur monthly. Further indications of this were the fact that the facilities were not being fully utilized and that approximately 50 percent of all transactions were not being delayed at all. Based on these indications, it was decided to rerun the simulation eliminating the monthly reports. It was felt that this does not detract from the simulation because the monthly reports are predictable and can be anticipated by supervisory personnel. The elimination of the monthly reports from the simulation gives a better indication of the random daily loading of personnel management and personnel records which is of more interest.

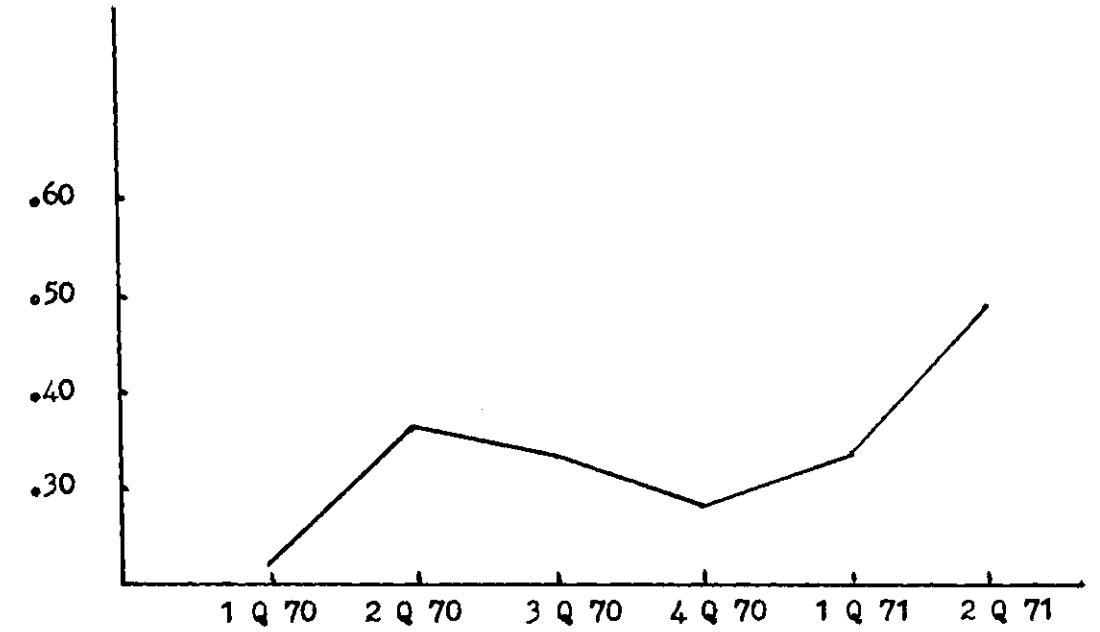



Facility Utilization




Queue Delay

Figure 17. Personnel Management - Organization 1



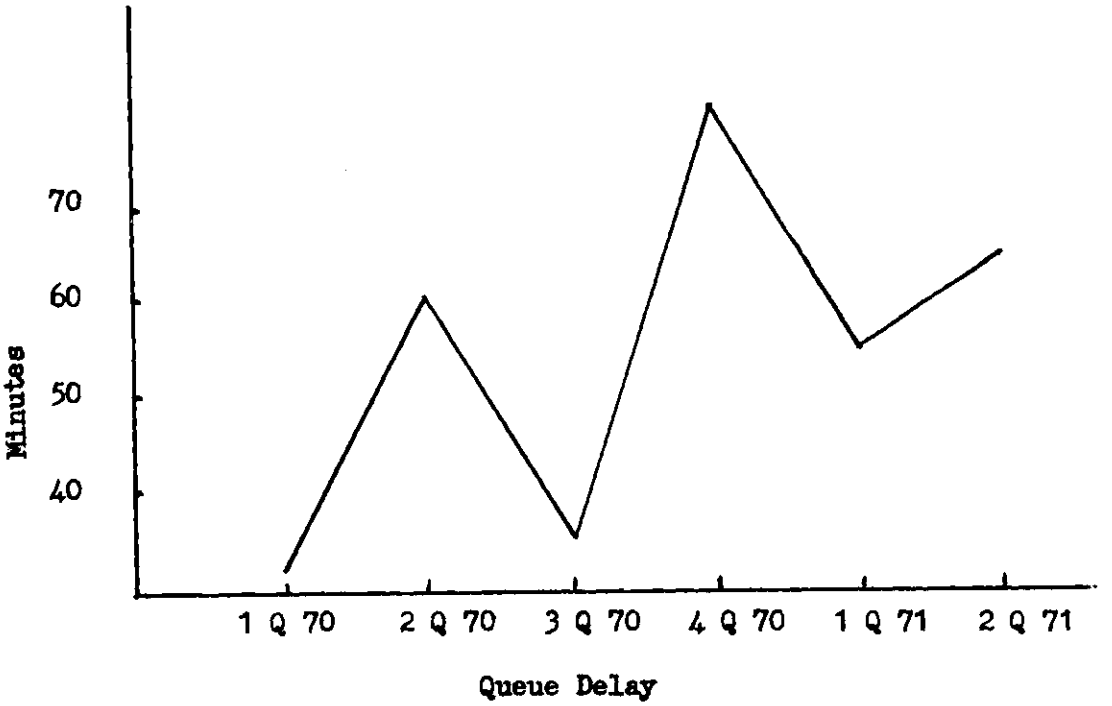
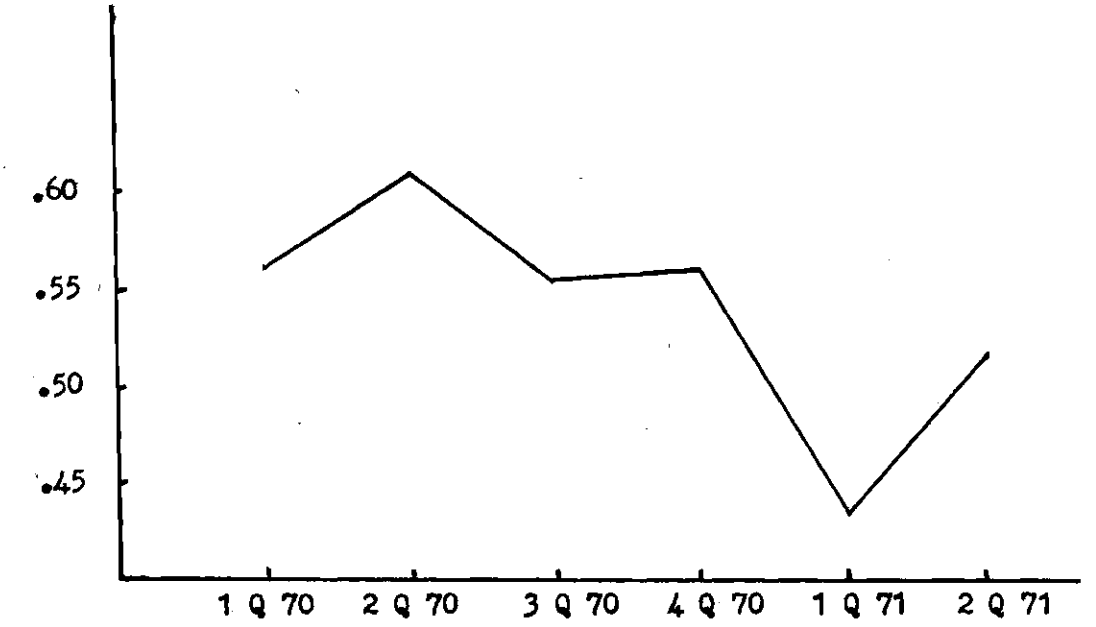
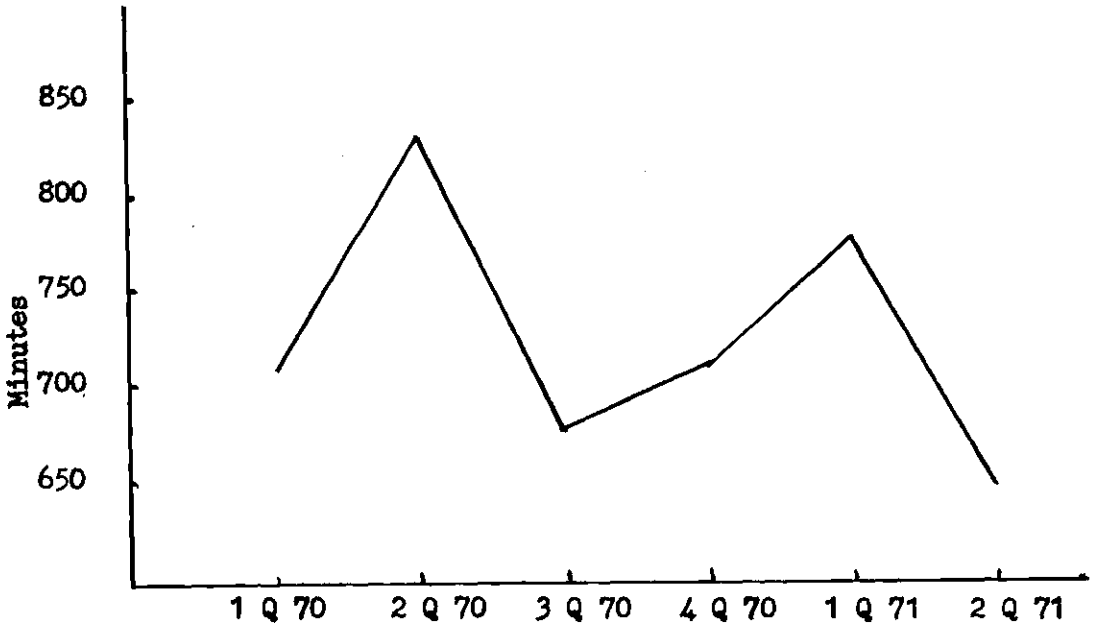




Figure 18. Personnel Actions - Organization 1

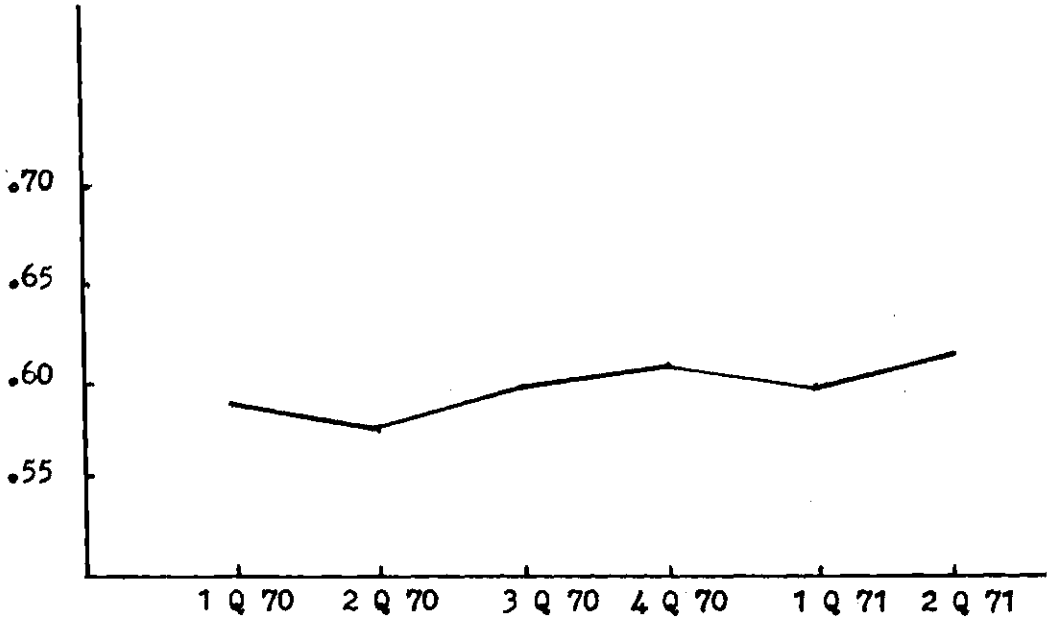



Facility Utilization



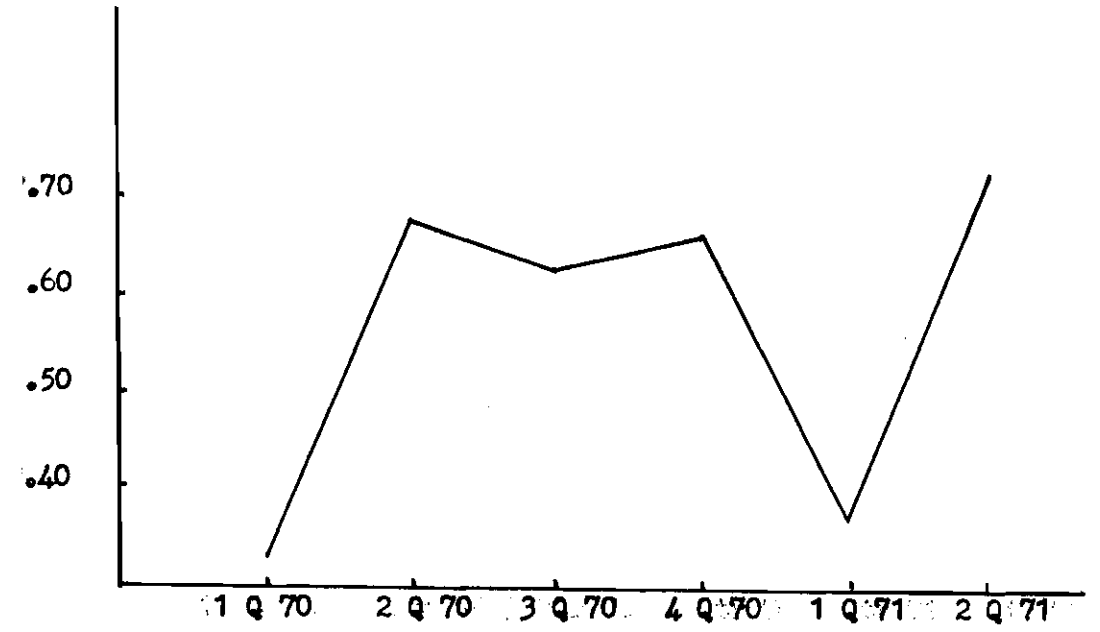

Queue Delay

Figure 19. Personnel Records - Organization 1

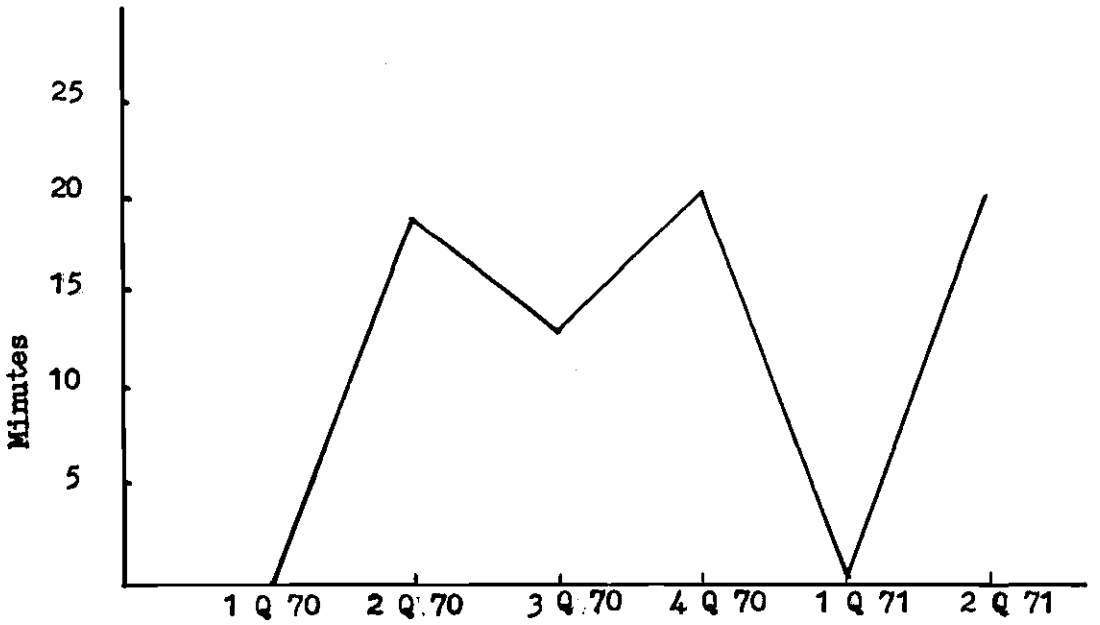



No transactions were delayed.

Figure 20. Reports Specialist - Organization 1




Facility Utilization

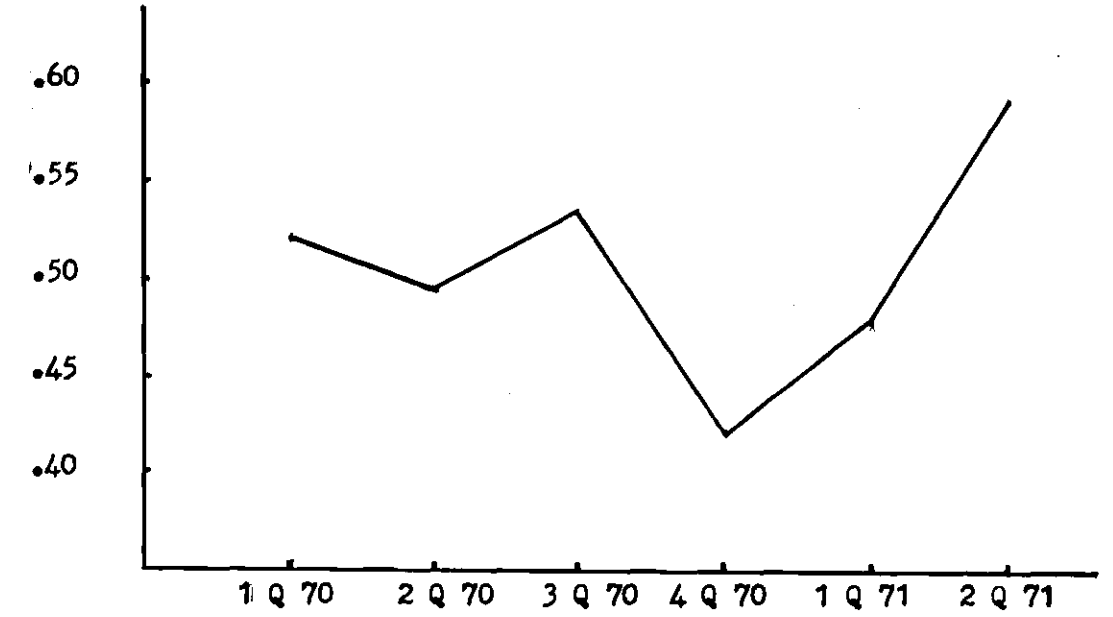



Queue Delay

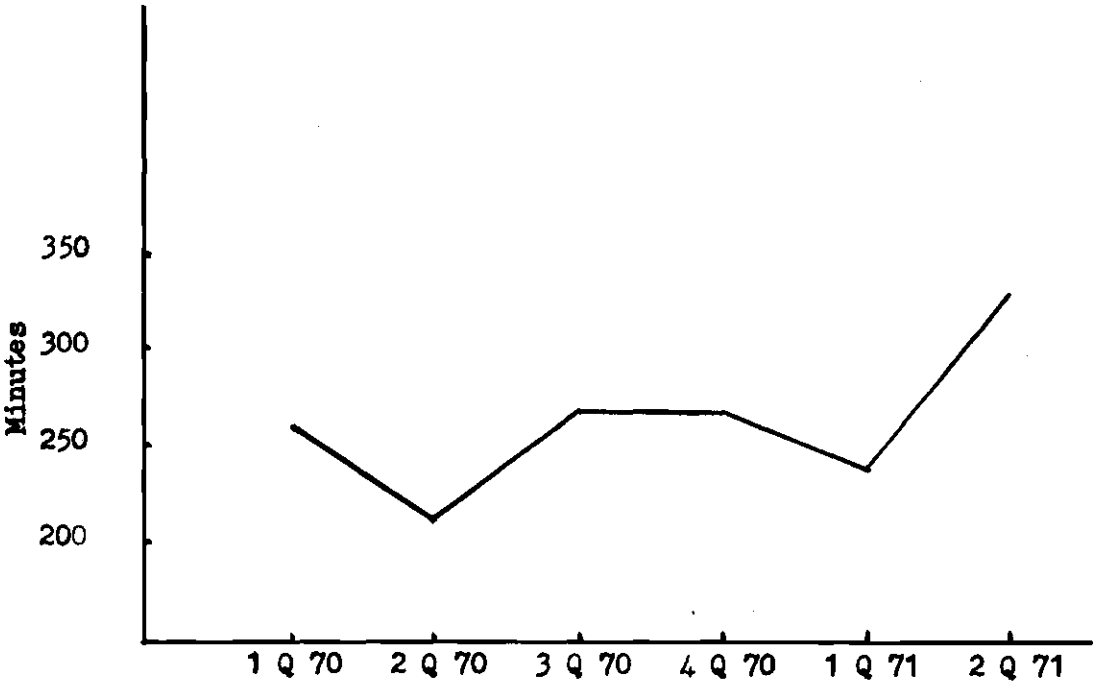
Figure 21. Processing - Organization 1

Table 5. Organization No. 1 Experiment No. 1

| Facility Number | 1Q70 FAC | 1Q70 Q | 2Q70 FAC | 2Q70 Q | 3Q70 FAC | 3Q70 Q | 4Q70 FAC | 4Q70 Q | 1Q71 FAC | 1Q71 Q | 2Q71 FAC | 2Q71 Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .3007 | 149 | .5943 | 235 | .4041 | 148 | .3931 | 165 | .3565 | 94 | .4088 | 152 |
| 2 | .5845 | 389 | .3567 | 144 | .5705 | 178 | .3696 | 524 | .5400 | 328 | .6507 | 203 |
| 3 | .3805 | 249 | .3032 | 154 | .5363 | 314 | .3131 | 92 | .3859 | 164 | .6743 | 430 |
| $\bar{1}$ | .4219 | 244 | .4180 | 178 | .5036 | 213 | .3586 | 260 | .4274 | 195 | .5779 | 262 |
| 5 | .2177 | 22 | .3196 | 49 | .2919 | 42 | .3021 | 91 | .2729 | 29 | .4490 | 55 |
| 6 | .2557 | 42 | .3929 | 70 | .3361 | 29 | .2690 | 70 | .3655 | 82 | .5779 | 72 |
| $\bar{2}$ | .2367 | 32 | .3562 | 60 | .3140 | 35 | .2855 | 80 | .3192 | 55 | .4834 | 64 |
| 8 | .5519 | 741 | .6037 | 869 | .5417 | 709 | .5472 | 646 | .4303 | 724 | .4952 | 584 |
| 9 | .5612 | 792 | .6042 | 974 | .5657 | 757 | .5557 | 705 | .4407 | 820 | .5115 | 671 |
| 11 | .5643 | 657 | .6067 | 784 | .5555 | 647 | .5459 | 709 | .4492 | 778 | .5012 | 699 |
| 12 | .5657 | 634 | .6052 | 834 | .5505 | 608 | .5502 | 717 | .4369 | 709 | .5049 | 622 |
| 14 | .5649 | 663 | .5990 | 817 | .5417 | 718 | .5589 | 700 | .4447 | 754 | .5071 | 608 |
| 15 | .5598 | 767 | .5990 | 718 | .5483 | 622 | .5516 | 769 | .4306 | 877 | .5757 | 714 |
| $\bar{3}$ | .5613 | 709 | .6029 | 833 | .5505 | 677 | .5515 | 708 | .4387 | 777 | .5059 | 649 |
| 17 | .5850 | 0 | .5729 | 0 | .5983 | 0 | .6012 | 0 | .5946 | 0 | .6037 | 0 |
| $\bar{4}$ | .5850 | 0 | .5729 | 0 | .5983 | 0 | .6012 | 0 | .5946 | 0 | .6037 | 0 |
| 21 | .2772 | 0 | .6623 | 21 | .6193 | 12 | .6716 | 20 | .3835 | 0 | .7200 | 17 |
| 22 | .3766 | 0 | .7040 | 17 | .6182 | 13 | .6882 | 20 | .3407 | 0 | .7162 | 23 |
| $\bar{5}$ | .3269 | 0 | .6831 | 19 | .6188 | 13 | .6799 | 20 | .3621 | 0 | .7181 | 20 |

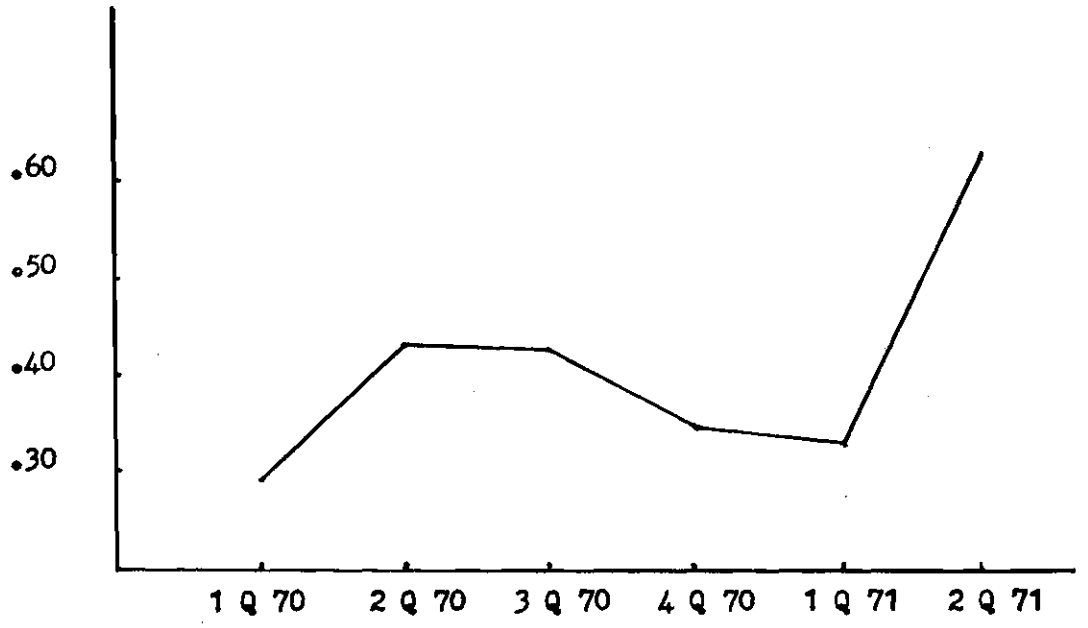



Facility Utilization

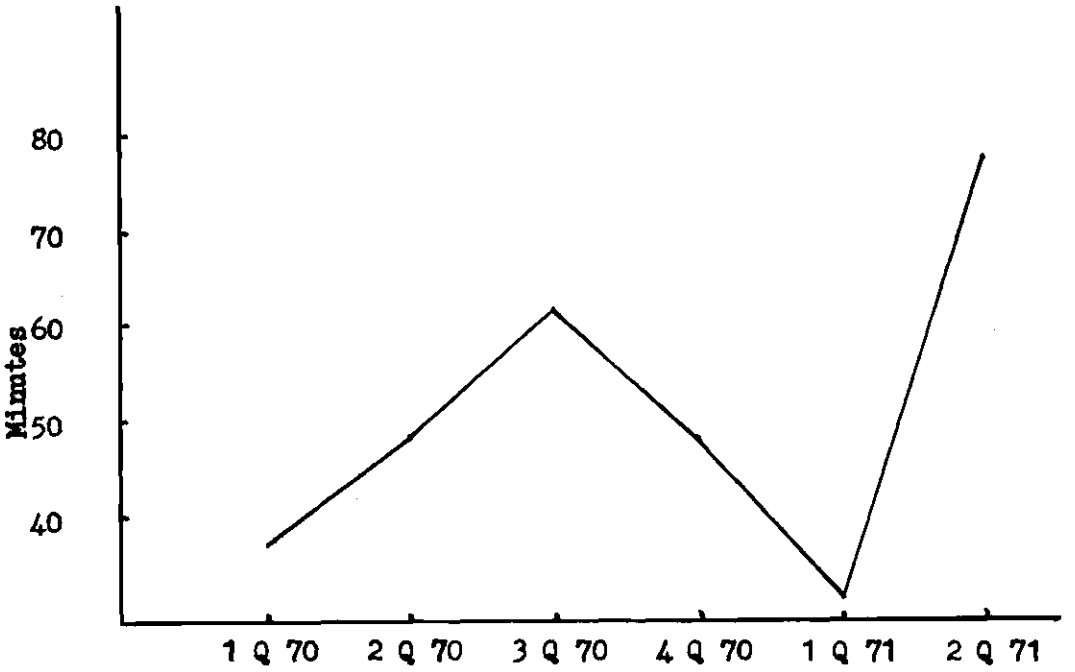



Queue Delay

Figure 22. Personnel Management - Organization 2

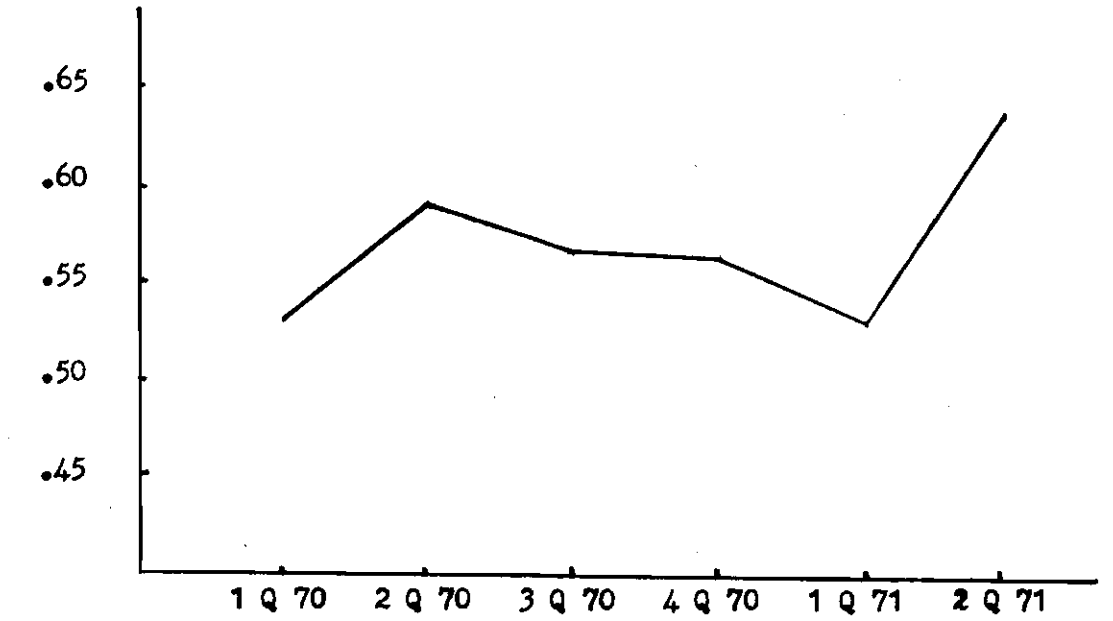



Facility Utilization




Queue Delay

Figure 23. Personnel Actions - Organization 2



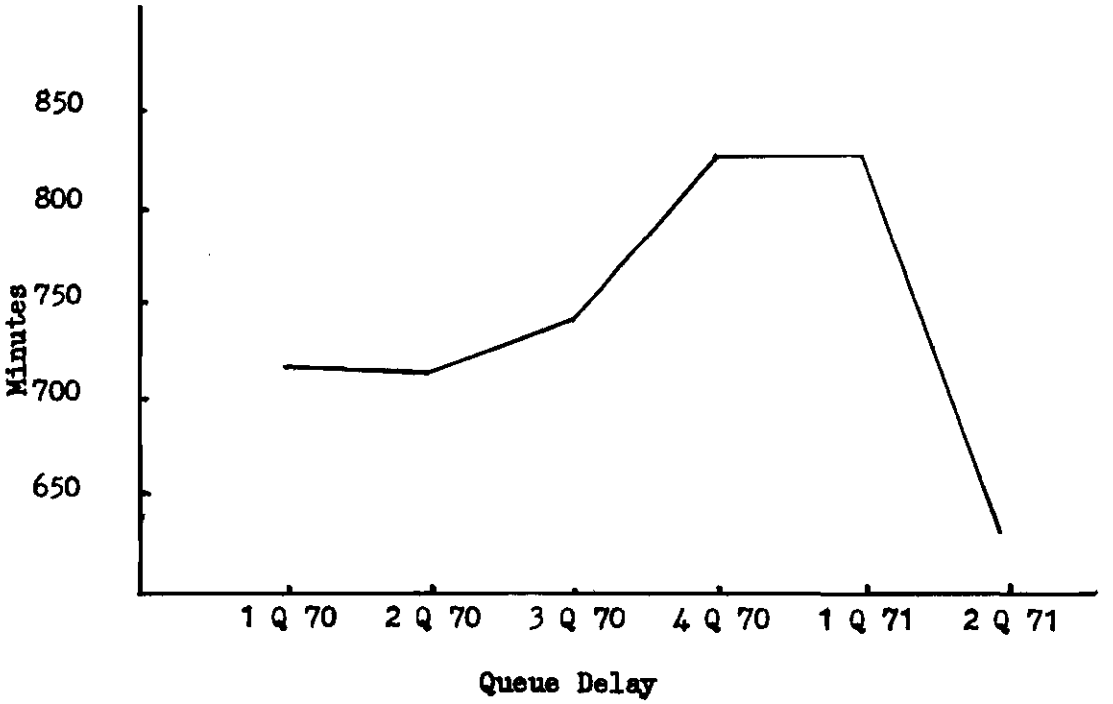
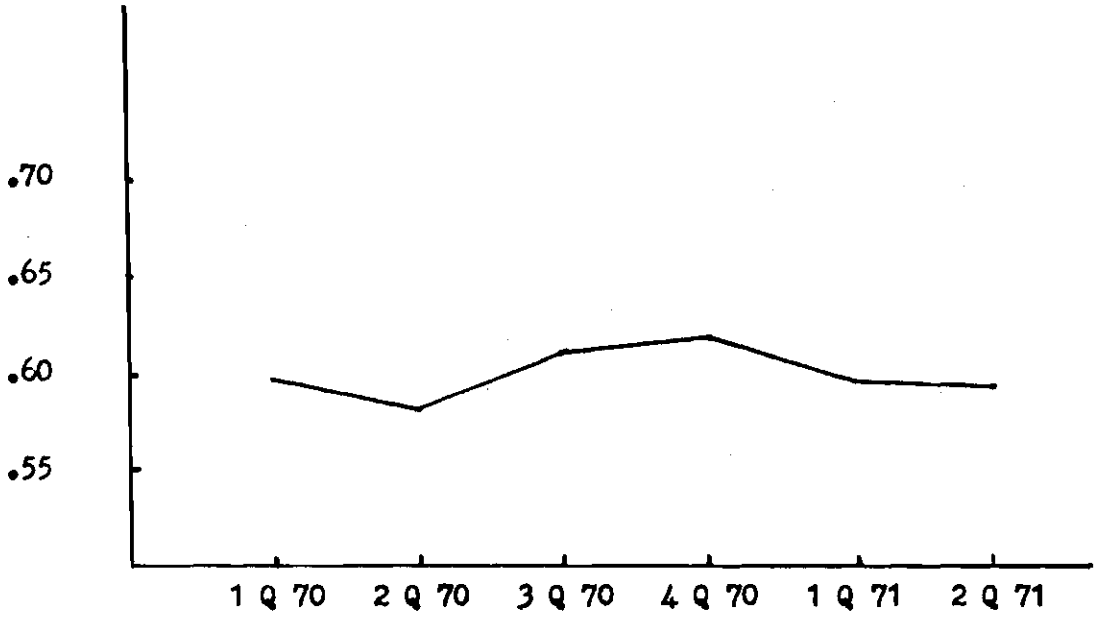
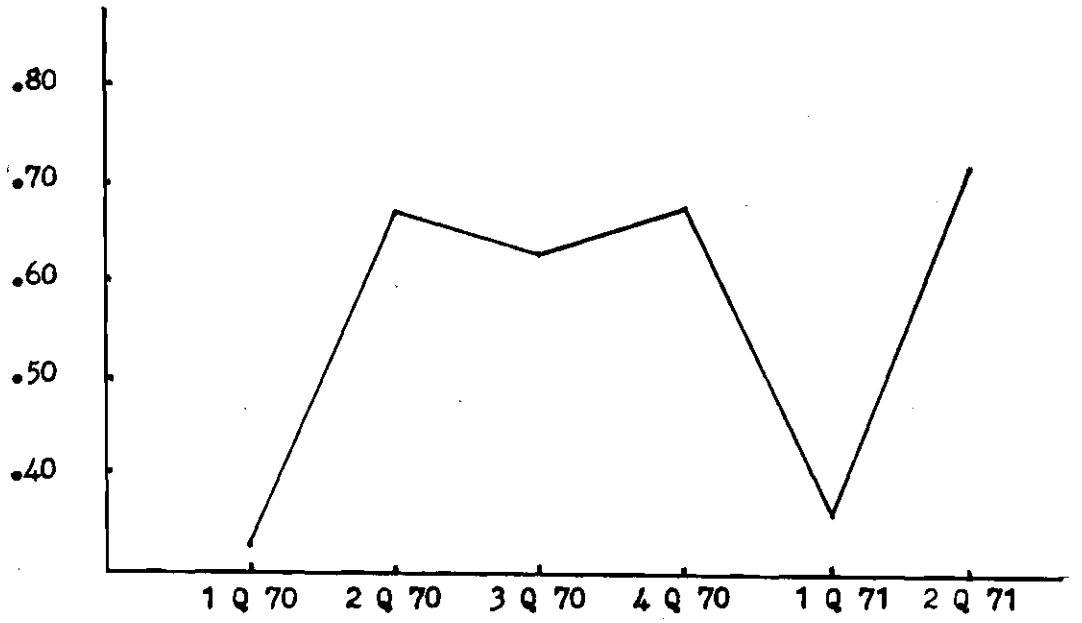




Figure 24. Personnel Records - Organization 2

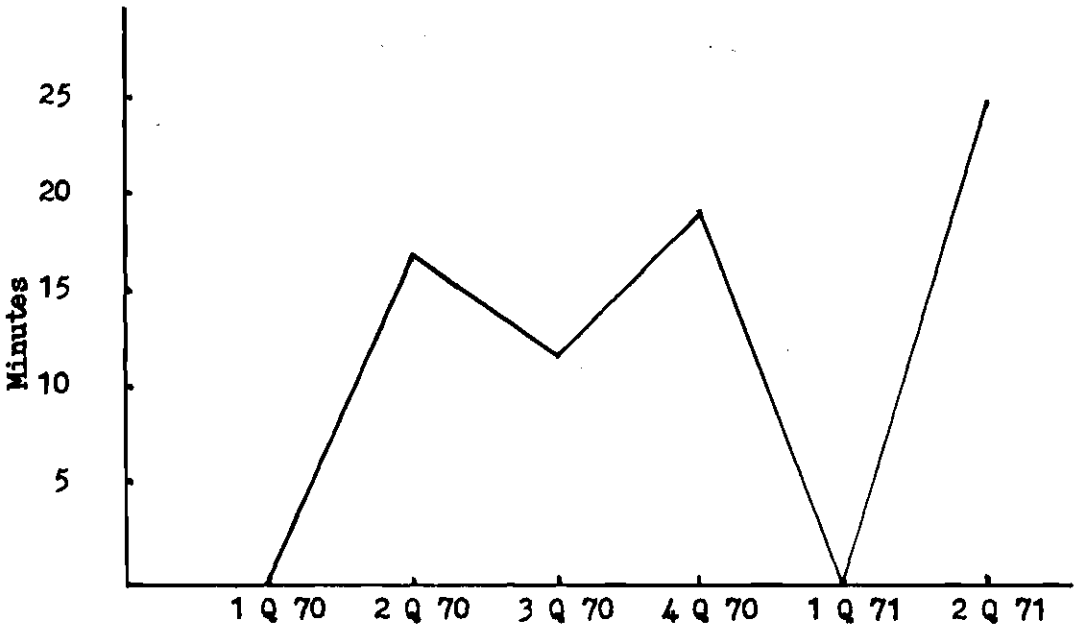



**No transactions were delayed.**

Figure 25. Reports Specialist - Organization 2




Facility Utilization

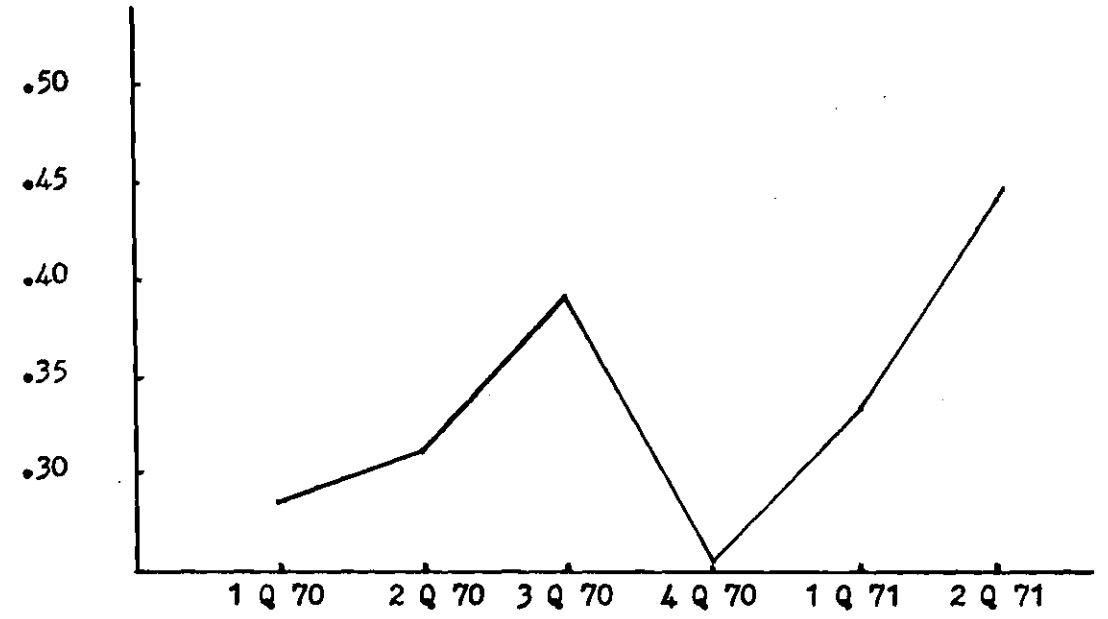



Queue Delay

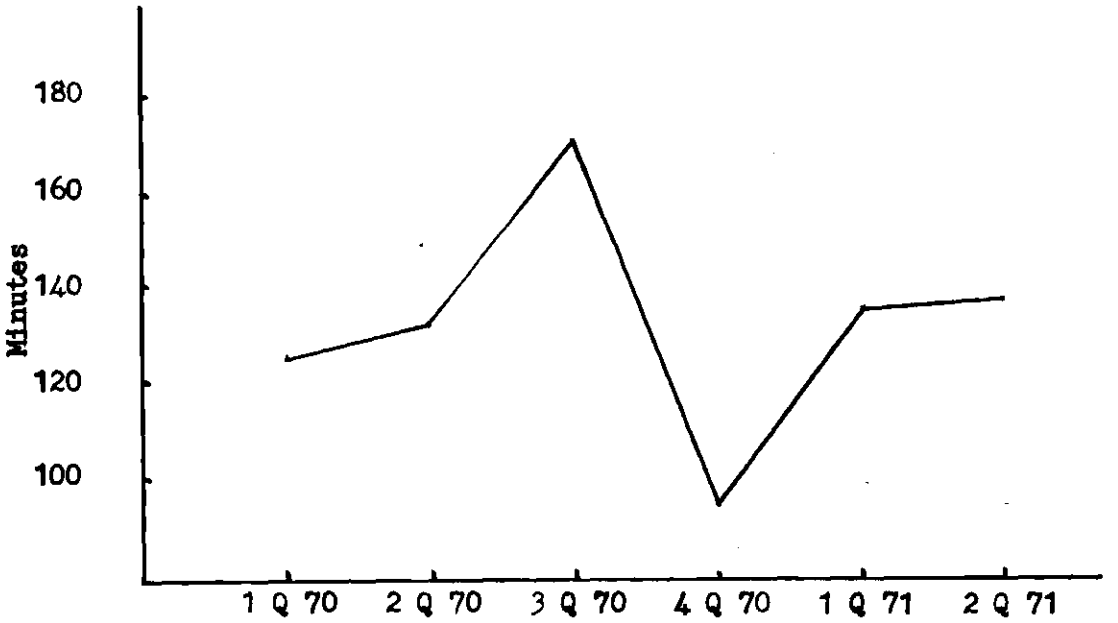
Figure 26. Processing -Organization 2

Table 6. Organization No. 2 Experiment No. 1

| Facility Number | 1Q70 FAC | 1Q70 Q | 2Q70 FAC | 2Q70 Q | 3Q70 FAC | 3Q70 Q | 4Q70 FAC | 4Q70 Q | 1Q71 FAC | 1Q71 Q | 2Q71 FAC | 2Q71 Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .3147 | 67 | .1832 | 35 | .3319 | 82 | .2051 | 43 | .2036 | 62 | .3926 | 211 |
| 2 | .5296 | 213 | .5485 | 166 | .4379 | 120 | .5075 | 204 | .5770 | 185 | .5757 | 296 |
| 3 | .5196 | 387 | .5959 | 348 | .7282 | 540 | .4439 | 435 | .5236 | 386 | .7164 | 423 |
| $\bar{x}$ | .5226 | 254 | .4944 | 213 | .5328 | 265 | .4215 | 264 | .4809 | 241 | .5953 | 329 |
| 4 | .2337 | 17 | .3228 | 18 | .3327 | 30 | .2384 | 13 | .3289 | 28 | .4902 | 48 |
| 5 | .3288 | 56 | .4968 | 65 | .4814 | 78 | .3987 | 67 | .3393 | 38 | .6832 | 98 |
| $\bar{x}$ | .2971 | 37 | .4386 | 49 | .4318 | 62 | .3452 | 49 | .3358 | 33 | .6188 | 73 |
| 6 | .5231 | 680 | .6017 | 752 | .5832 | 686 | .5532 | 803 | .5397 | 783 | .6297 | 566 |
| 7 | .5416 | 747 | .5850 | 703 | .5573 | 820 | .5564 | 866 | .5293 | 759 | .6525 | 707 |
| 8 | .5367 | 802 | .5934 | 646 | .5534 | 721 | .5592 | 745 | .5206 | 908 | .6384 | 600 |
| 9 | .5283 | 608 | .5922 | 719 | .5611 | 735 | .5734 | 898 | .5472 | 846 | .6373 | 664 |
| $\bar{x}$ | .5324 | 709 | .5930 | 705 | .5637 | 741 | .5605 | 828 | .5342 | 824 | .6394 | 634 |
| 10 | .5992 | 0 | .5771 | 0 | .6096 | 0 | .6179 | 0 | .5979 | 0 | .5942 | 0 |
| $\bar{x}$ | .5992 | 0 | .5771 | 0 | .6096 | 0 | .6179 | 0 | .5979 | 0 | .5942 | 0 |
| 11 | .3112 | 0 | .6814 | 16 | .6213 | 12 | .6852 | 19 | .3567 | 0 | .6562 | 19 |
| 12 | .3397 | 0 | .6778 | 17 | .6358 | 11 | .6794 | 19 | .3634 | 0 | .7702 | 31 |
| $\bar{x}$ | .3254 | 0 | .6796 | 17 | .6285 | 12 | .6823 | 19 | .3600 | 0 | .7132 | 25 |

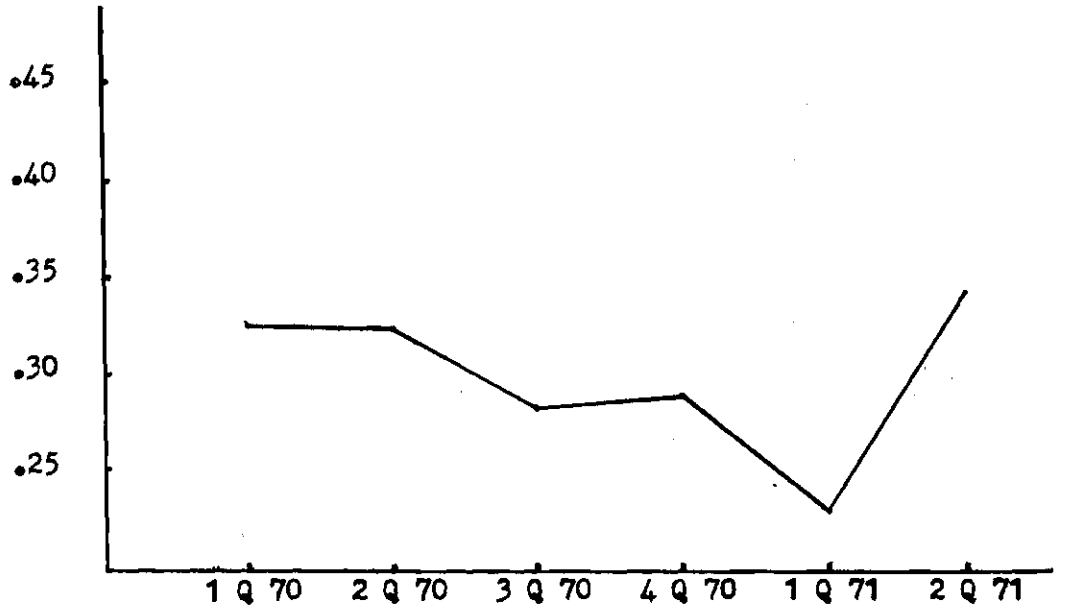



Facility Utilization

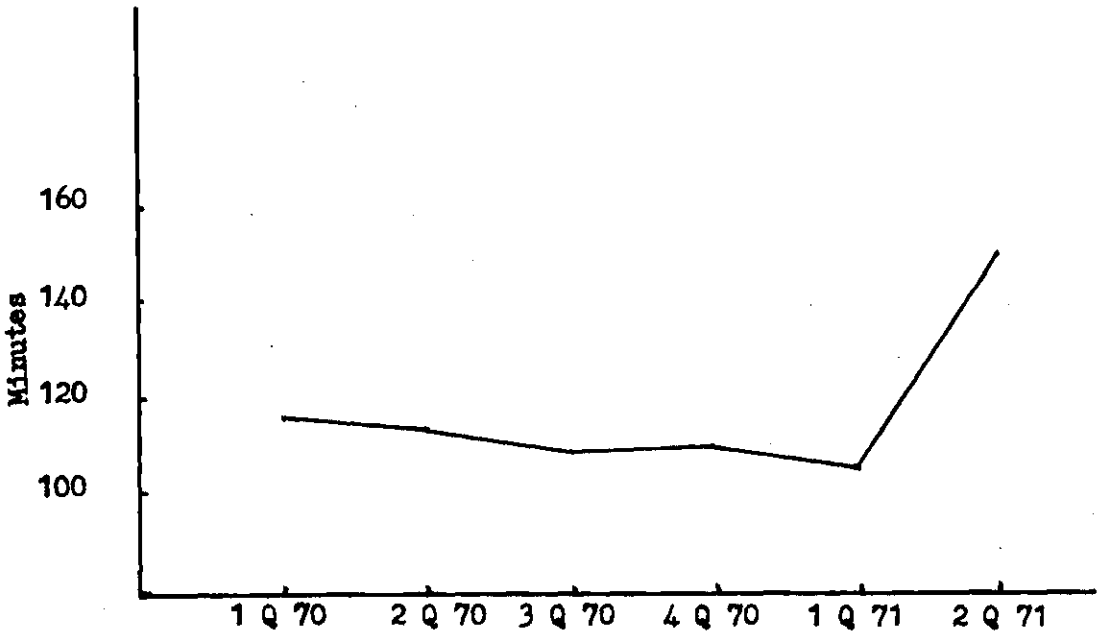



Queue Delay

Figure 27. Personnel Management - Organization 1
(Without Monthly Transactions)

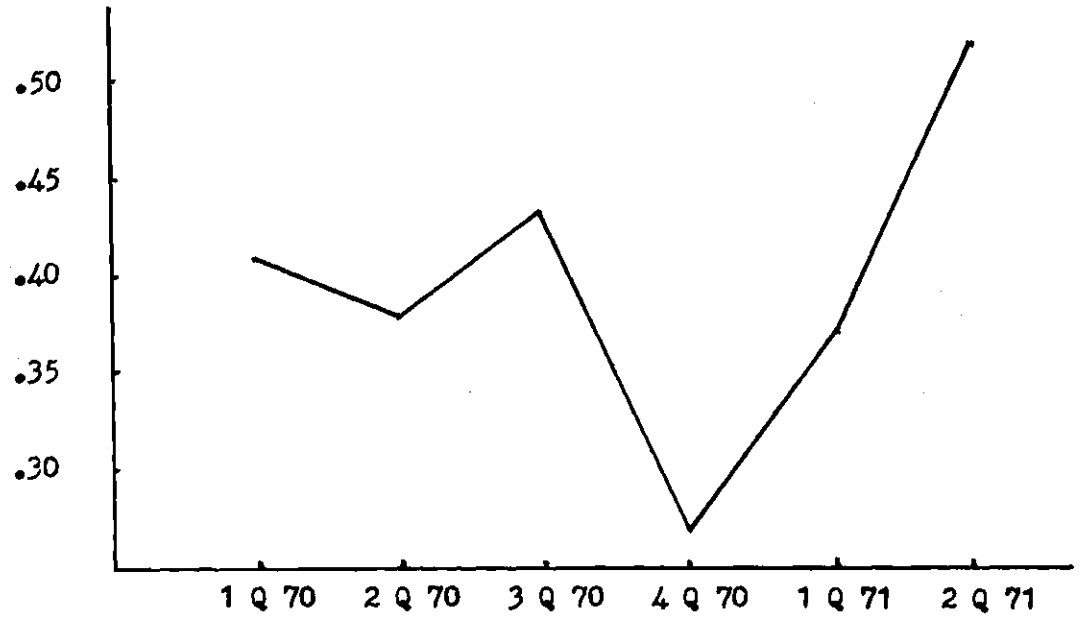



Facility Utilization

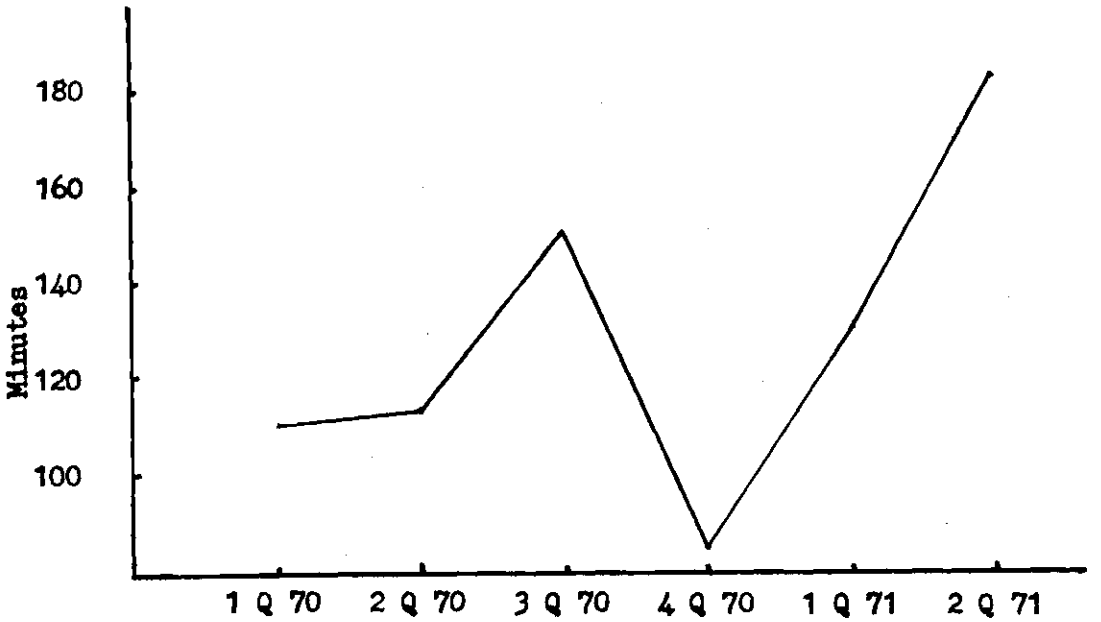



Queue Delay

Figure 28. Personnel Records - Organization 1
(Without Monthly Transactions)

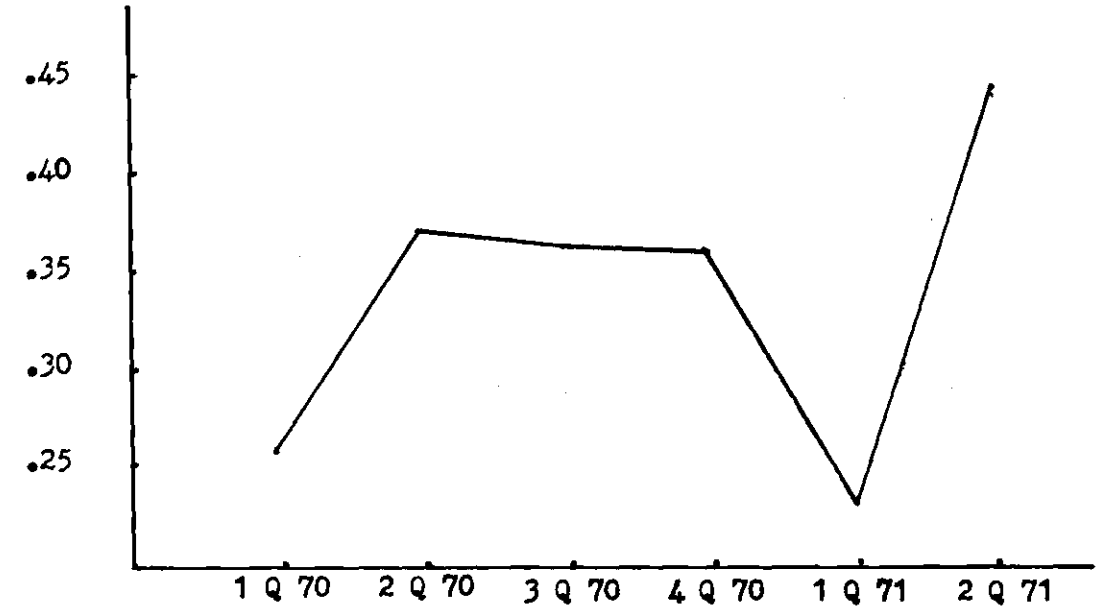



Facility Utilization

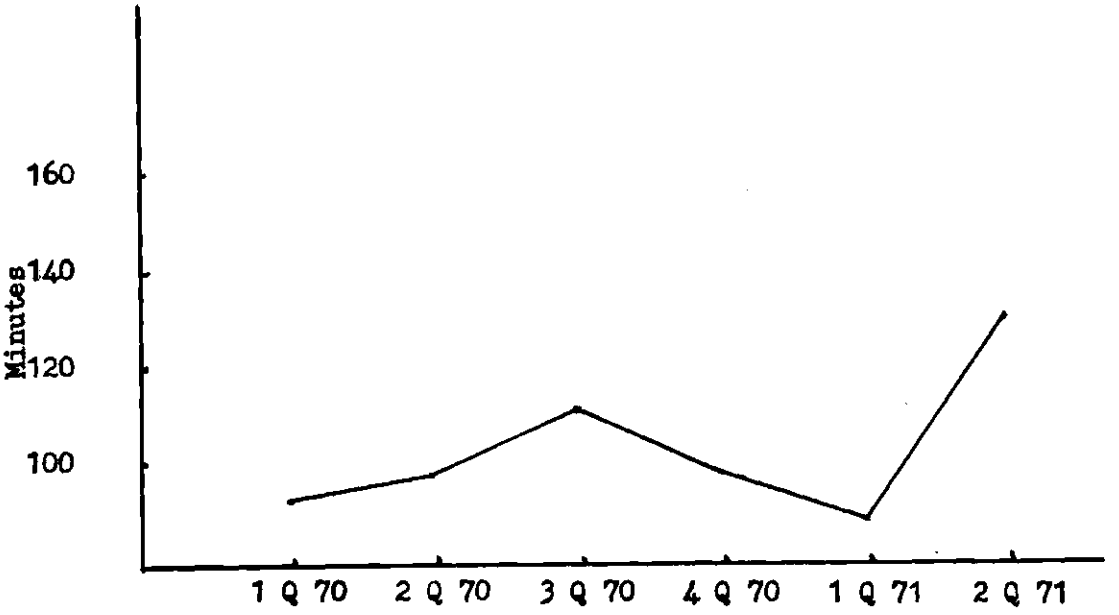



Queue Delay

Figure 29. Personnel Management - Organization 2 (Without Monthly Transactions)




Facility Utilization




Queue Delay

Figure 30. Personnel Records - Organization 2
(Without Monthly Transactions)

Table 7. Experiment No. 1 Without Monthly Transactions

| Facility Number | 1Q70 FAC | 1Q70 Q | 2Q70 FAC | 2Q70 Q | 3Q70 FAC | 3Q70 Q | 4Q70 FAC | 4Q70 Q | 1Q71 FAC | 1Q71 Q | 2Q71 FAC | 2Q71 Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORGANIZATION #1 | | | | | | | | | | | | |
| 1 | .2808 | 122 | .3801 | 103 | .3796 | 238 | .2977 | 85 | .2567 | 102 | .4377 | 135 |
| 2 | .2689 | 106 | .2639 | 186 | .3512 | 140 | .2373 | 64 | .3045 | 134 | .5126 | 145 |
| 3 | .3163 | 147 | .2824 | 110 | .4507 | 139 | .2281 | 133 | .4530 | 178 | .3927 | 137 |
| $\bar{\mu}$ | .2886 | 125 | .3088 | 133 | .3938 | 172 | .2543 | 94 | .3380 | 138 | .4476 | 139 |
| 8 | .3306 | 123 | .3231 | 137 | .2852 | 90 | .2885 | 97 | .2327 | 89 | .3517 | 138 |
| 9 | .3341 | 114 | .3287 | 117 | .2851 | 117 | .2969 | 108 | .2269 | 103 | .3427 | 140 |
| 11 | .3303 | 114 | .3322 | 107 | .2830 | 114 | .2823 | 107 | .2315 | 132 | .3521 | 179 |
| 12 | .3265 | 138 | .3323 | 104 | .2821 | 106 | .2831 | 103 | .2350 | 100 | .3415 | 160 |
| 14 | .3217 | 100 | .3361 | 113 | .2764 | 113 | .3004 | 119 | .2303 | 111 | .3464 | 138 |
| 15 | .3315 | 117 | .3190 | 117 | .2815 | 103 | .2835 | 126 | .2383 | 88 | .3427 | 142 |
| $\bar{\mu}$ | .3291 | 118 | .3285 | 116 | .2822 | 107 | .2891 | 110 | .2324 | 104 | .3461 | 150 |
| ORGANIZATION #2 | | | | | | | | | | | | |
| 1 | .1287 | 27 | .2045 | 43 | .2727 | 78 | .1686 | 22 | .2269 | 65 | .3276 | 110 |
| 2 | .3932 | 134 | .3533 | 117 | .5227 | 176 | .3208 | 129 | .3764 | 157 | .6006 | 223 |
| 3 | .5582 | 144 | .5722 | 157 | .4305 | 158 | .2544 | 74 | .4377 | 137 | .5737 | 176 |
| $\bar{\mu}$ | .4063 | 116 | .3871 | 118 | .4358 | 149 | .2638 | 86 | .3710 | 131 | .5712 | 182 |
| 6 | .2592 | 84 | .3901 | 102 | .3840 | 104 | .3752 | 94 | .2388 | 92 | .4581 | 126 |
| 7 | .2592 | 93 | .3661 | 104 | .3652 | 109 | .3553 | 102 | .2287 | 84 | .4497 | 131 |
| 8 | .2511 | 96 | .3707 | 89 | .3629 | 115 | .3713 | 95 | .2263 | 91 | .4407 | 122 |
| 9 | .2570 | 97 | .3757 | 96 | .3611 | 118 | .3620 | 102 | .2317 | 81 | .4432 | 134 |
| $\bar{\mu}$ | .2566 | 92 | .3756 | 97 | .3683 | 112 | .3659 | 98 | .2313 | 87 | .4479 | 128 |

Figures 27, 28, 29, 30 and Table 7 show the results of eliminating the monthly transactions. Only the responses for personnel management and personnel records are shown since the other elements of a composite team do not process any monthly transactions and therefore were unaffected.

From this experiment it was determined that both organizations can accommodate the workload. Supervisors in personnel management and personnel records should be conscious of the input of monthly reports and make plans in advance to offset their impact.

## Experiment 2

The objective of experiment number two is to compare the two organizations. If organization No 2 has a facility utilization at least as high as organization No 1, without developing queue delays in excess of the standards established at the beginning of this chapter, then it will be considered the better organization because it is smaller.

Monthly transactions will not be considered because the effect of the random daily transactions is of primary interest. Also, the second subroutine for generating transactions will be used in order to generate the same set of transactions for each model.

Figures 31 through 34 and Table 8 show the results of this experiment. The dashed lines are for organization No. 1, the solid lines for organization No. 2. Note that there is no graph for the reports specialists; this is because the results were exactly the same in all cases for both organizations. Note that the processing

element (Figure 34) has exactly the same mean utilization for both organizations. However, the mean queue delay for transactions that were delayed is not the same in all cases. This is due to the fact that the selection of the facilities is based on the same random number sequence that is being used by other elements in the model. Therefore, even though this element in both organizations is the same, the transactions are not processed in exactly the same manner in both organizations, causing the difference in delay.

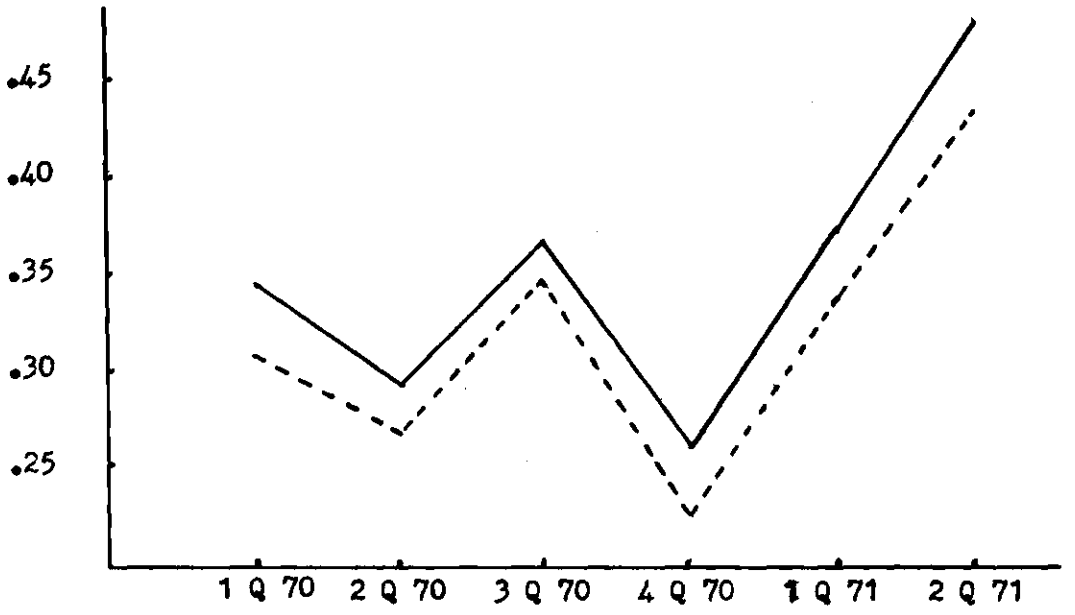
In the personnel management and personnel actions elements (Figures 31, 32), the facility utilization is in all cases numerically higher in organization No. 2 than in organization No. 1. Again the mean queue delays show no consistency; however, in all cases, they meet the 200 minute standard.

The problem arises in the records element (Figure 33). Here again, the facility utilization is in all cases numerically better for organization No. 2 than organization No. 1. However, in the third quarter of 1970, both organizations have high mean queue delays with organization No. 2 going over 200 minutes. This result is somewhat surprising since experiment one gave no indication that this would occur, nor will the result be indicated by experiment three. Note also that the facility utilization for the third quarter 1970 is not excessively high. An examination was made of the number and type of transactions processed by records element and it was found to be less in number than those processed in experiment three. More importantly, they were less in number of those types of

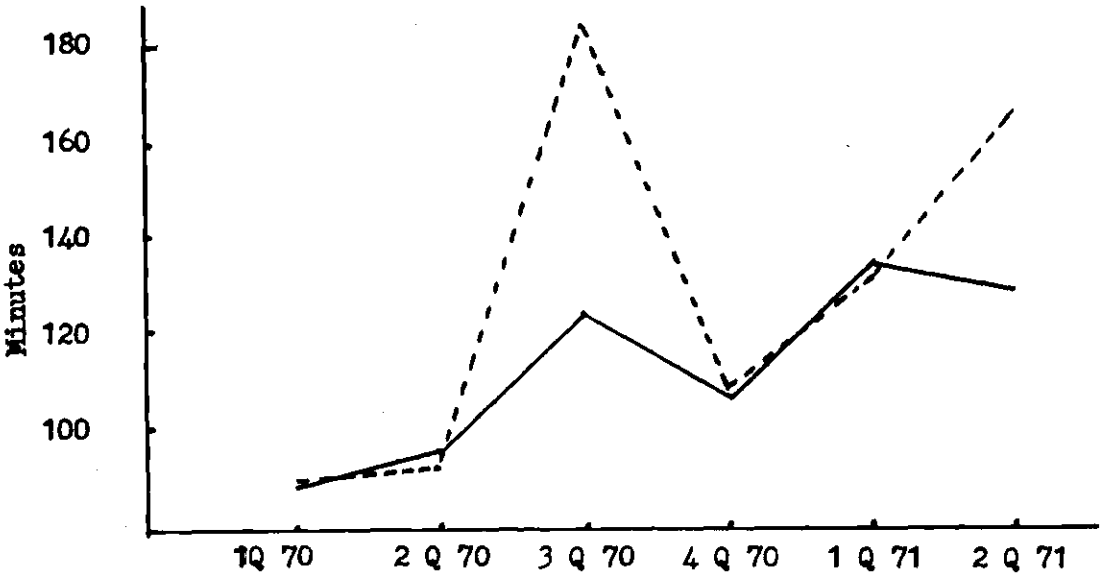
transactions which have long action times. With no apparent explanation to this response, it was decided to re-run the simulations on this data, changing the random number seed. When this was done, the results were more in line with those of experiments one and three and met the 200 minute standard.

The problem of exceeding the standards set for the experiment in the case of the records element presents a dilemma to the experimentor. Should he hold steadfastly to the standards, or consider other factors? It was decided to ignore the results of the third quarter 1970 in this experiment because they were not consistent with other results, and at best, were an extreme response which should not be used as a basis for a major change in the organization. Therefore, it was determined that the objectives of experiment two had been reasonably met and organization No. 2 is the better of the two organizations.

No statistical analysis was conducted on experiment two for several reasons. Firstly, limitations on computer time precluded the running of sufficient iterations of the experiment to get enough responses to insure statistical reliability. Secondly, because of the irregular response of the queue delays between the two organizations, a statistical analysis on these responses would be meaningless. Thirdly, because of the range of responses in most cases, a statistical analysis would, in all likelihood, not alter any decisions made concerning the design of organization No. 2.

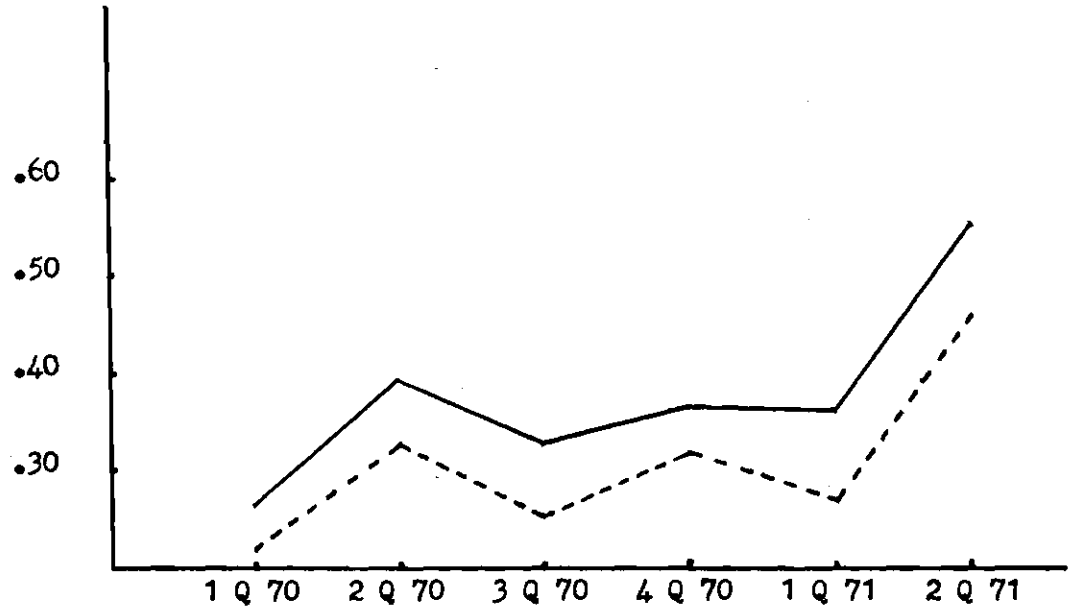



Facility Utilization

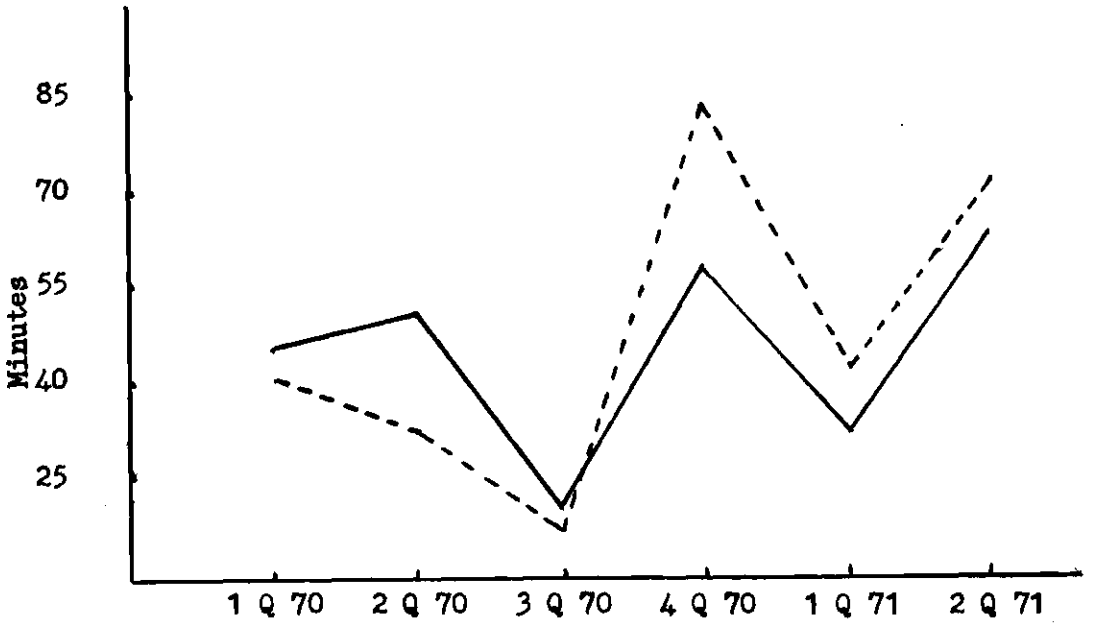



Queue Delay

Figure 31. Personnel Management - Comparison

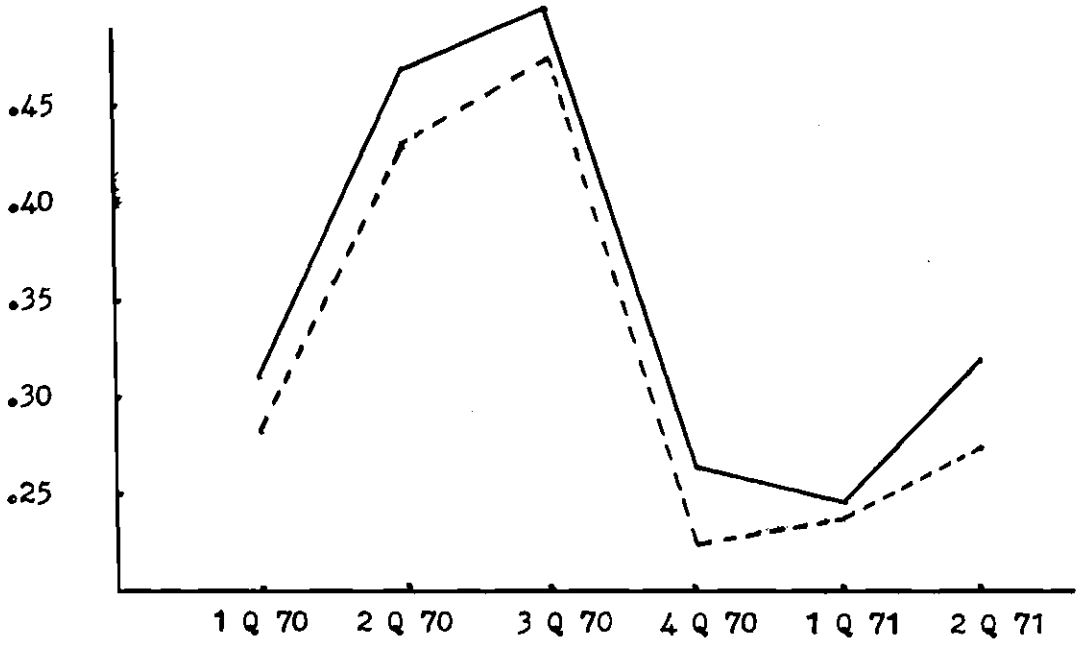



Facility Utilization




Queue Delay

Figure 32. Personnel Actions - Comparison



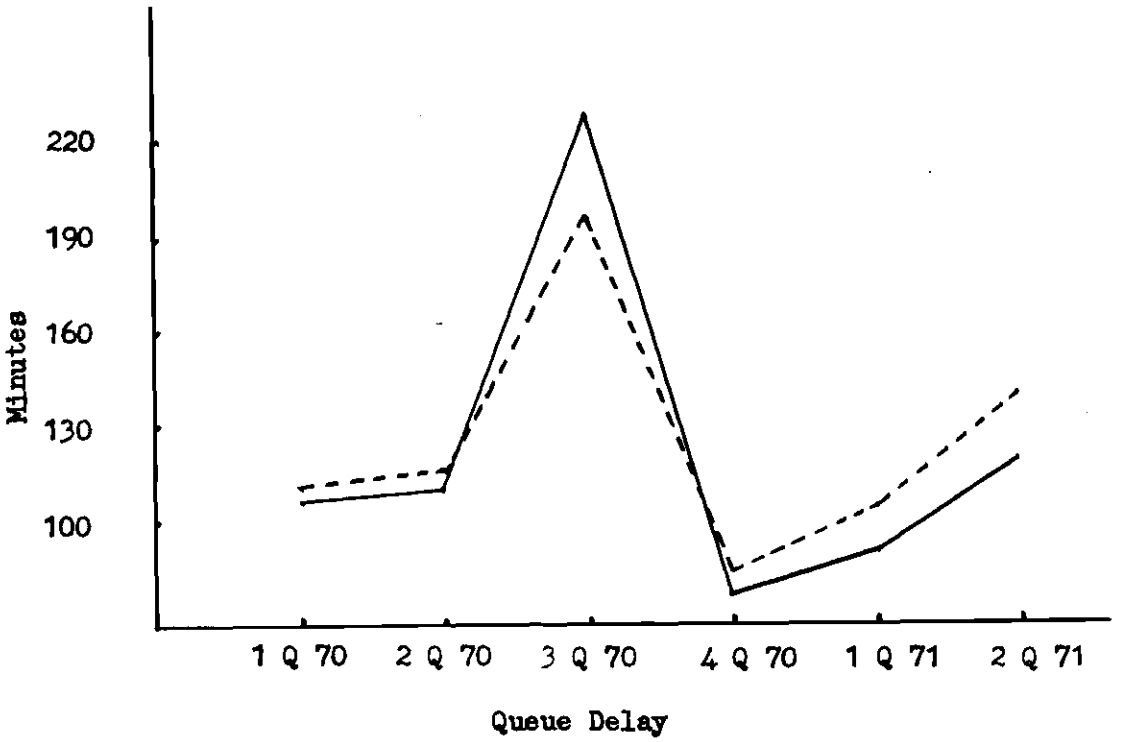
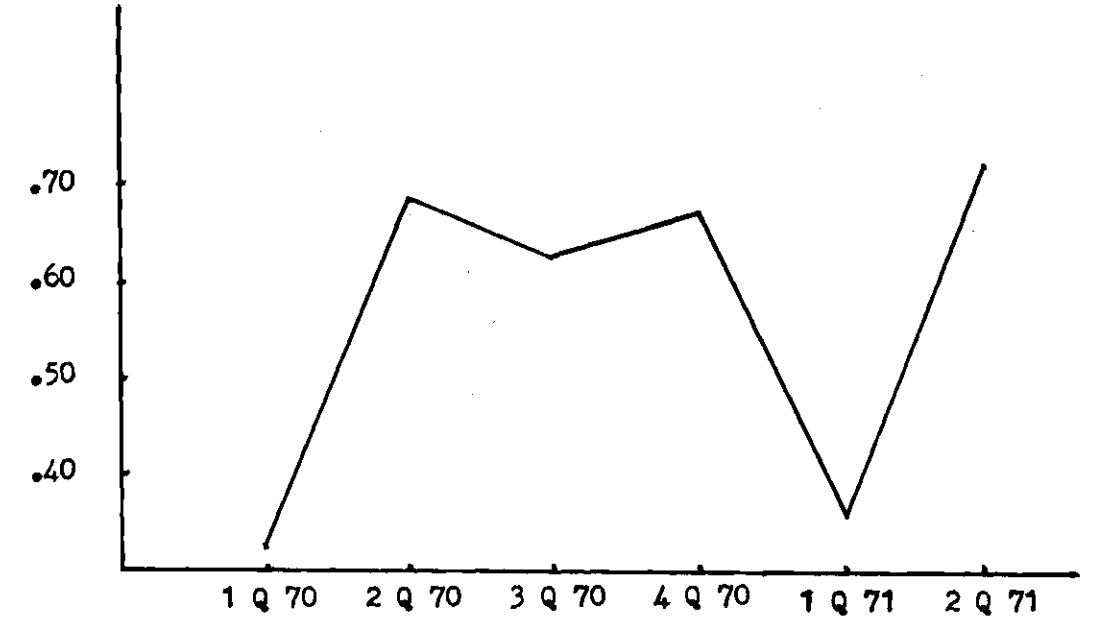
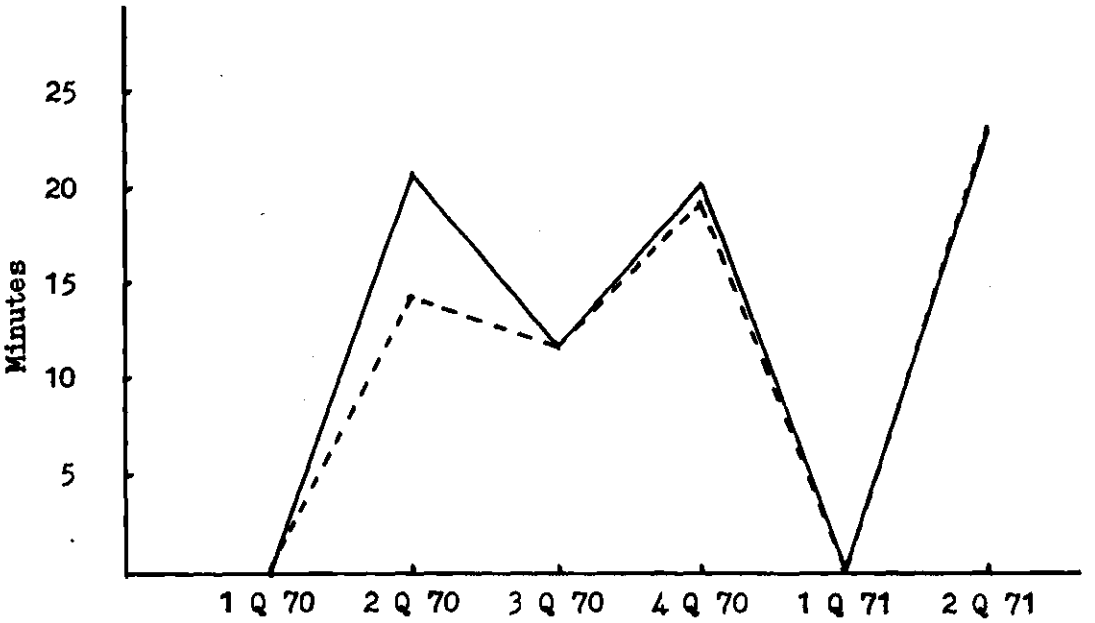




Figure 33. Personnel Records - Comparison




Facility Utilization




Queue Delay

Figure 34. Personnel Processing - Comparison

Table 8. Comparison of Organizations No. 1 and No. 2

| | | FACILITY UTILIZATION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facility Number | | 1Q70 | | 2Q70 | | 3Q70 | | 4Q70 | | 1Q71 | | 2Q71 | |
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Management | 1 | .3406 | .2005 | .2627 | .2375 | .3062 | .3836 | .1516 | .1730 | .2434 | .2280 | .2344 | .3565 |
| | 2 | .2597 | .4085 | .2064 | .3344 | .3246 | .4514 | .2874 | .2940 | .3165 | .3864 | .5344 | .6231 |
| | 3 | .3154 | .3621 | .3184 | .2751 | .4089 | .2706 | .2416 | .2571 | .4530 | .4328 | .5385 | .4049 |
| | $\bar{\mu}$ | .3052 | .3483 | .8625 | .2913 | .3465 | .3655 | .2268 | .2550 | .3376 | .3732 | .4357 | .4825 |
| Actions | 4 | | .2156 | | .3251 | | .2726 | | .3179 | | .3140 | | .4825 |
| | 5 | .2346 | .2831 | .3285 | .4322 | .2664 | .3439 | .2801 | .3820 | .3150 | .3840 | .3770 | .5702 |
| | 6 | .1835 | | .3080 | | .2494 | | .3242 | | .2473 | | .5501 | |
| | $\bar{\mu}$ | .2090 | .2606 | .3182 | .3971 | .2579 | .3201 | .3021 | .3606 | .2811 | .3606 | .4635 | .5409 |
| Record | 6 | | .2921 | | .4742 | | .5015 | | .2562 | | .2488 | | .3431 |
| | 7 | | .3112 | | .4772 | | .5096 | | .2664 | | .2385 | | .3171 |
| | 8 | .2731 | .2926 | .4397 | .4706 | .4724 | .5099 | .2266 | .2434 | .2350 | .2263 | .2785 | .3017 |
| | 9 | .2787 | .3082 | .4377 | .4639 | .4740 | .5116 | .2241 | .2460 | .2303 | .2417 | .2861 | .2900 |
| | 11 | .2809 | | .4480 | | .4821 | | .2246 | | .2383 | | .2649 | |
| | 12 | .2892 | | .4287 | | .4805 | | .2162 | | .2270 | | .2522 | |
| | 14 | .2676 | | .4320 | | .4626 | | .2195 | | .2227 | | .2656 | |
| | 15 | .2892 | | .4396 | | .4797 | | .2244 | | .2393 | | .2644 | |
| | $\bar{\mu}$ | .2797 | .3010 | .4376 | .4714 | .4752 | .5081 | .2225 | .2530 | .2318 | .2392 | .2686 | .3129 |
| Reports | 10 | | .6019 | | .5700 | | .5481 | | .5700 | | .5721 | | .5619 |
| | 17 | .6019 | | .5700 | | .5481 | | .5700 | | .5721 | | .5619 | |
| | $\bar{\mu}$ | .6019 | .6019 | .5700 | .5700 | .5481 | .5481 | .5700 | .5700 | .5721 | .5721 | .5619 | .5619 |
| Process | 11 | | .3069 | | .6026 | | .5714 | | .7469 | | .3604 | | .6685 |
| | 12 | | .3462 | | .7619 | | .6860 | | .6076 | | .3560 | | .7536 |
| | 21 | .3797 | | .6747 | | .5967 | | .6105 | | .3672 | | .6760 | |
| | 22 | .2734 | | .6897 | | .6606 | | .7440 | | .3492 | | .7461 | |
| | $\bar{\mu}$ | .3265 | .3265 | .6822 | .6822 | .6286 | .6286 | .6722 | .6722 | .3582 | .3582 | .7110 | .7110 |

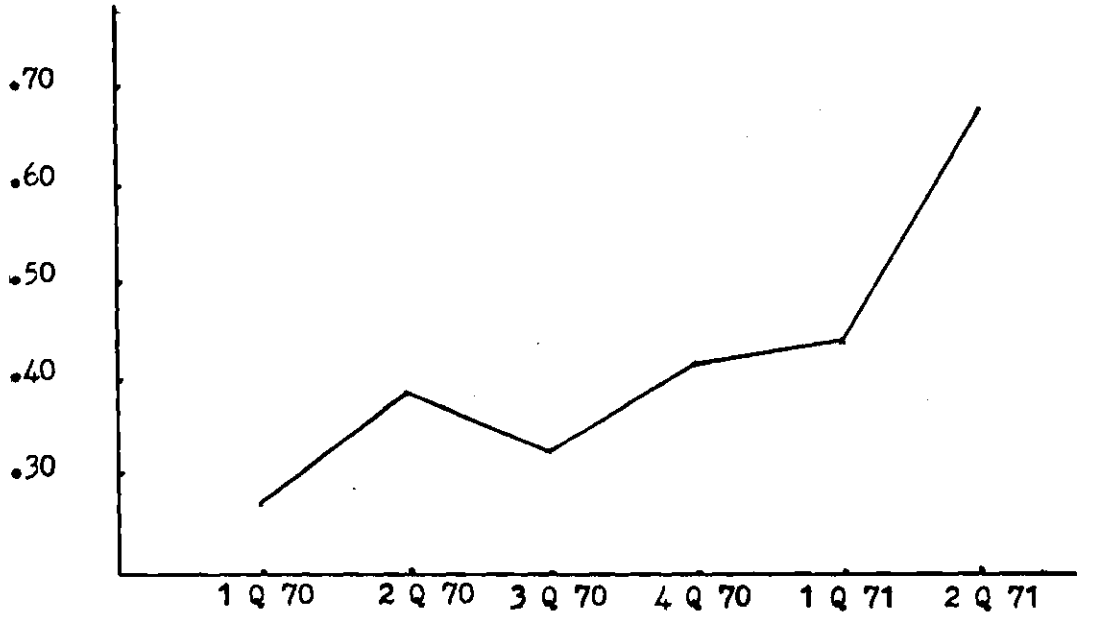
Table 8 Continued

| | QUEUE DELAY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facility | 1Q70 | | 2Q70 | | 3Q70 | | 4Q70 | | 1Q71 | | 2Q71 | |
| Number | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1 | 116 | 61 | 69 | 31 | 110 | 60 | 119 | 59 | 101 | 73 | 139 | 78 |
| 2 | 82 | 86 | 105 | 128 | 181 | 164 | 126 | 85 | 125 | 161 | 157 | 163 |
| 3 | 70 | 103 | 105 | 95 | 263 | 112 | 78 | 151 | 170 | 142 | 204 | 118 |
| $\bar{\mu}$ | 89.55 | 88 | 93 | 95 | 184 | 122 | 108 | 106 | 132 | 136 | 166 | 128 |
| 4 | | 4 | | 25 | | 7 | | 51 | | 28 | | 71 |
| 5 | 60 | 65 | 42 | 61 | 24 | 29 | 83 | 62 | 49 | 35 | 37 | 58 |
| 6 | 20 | | 21 | | 14 | | 85 | | 33 | | 106 | |
| $\bar{\mu}$ | 40 | 44 | 32 | 49 | 18 | 21 | 84 | 58 | 41 | 32 | 71 | 62 |
| 6 | | 119 | | 110 | | 232 | | 85 | | 94 | | 101 |
| 7 | | 93 | | 109 | | 292 | | 82 | | 89 | | 116 |
| 8 | 131 | 122 | 122 | 118 | 208 | 177 | 75 | 89 | 88 | 91 | 167 | 153 |
| 9 | 115 | 91 | 115 | 118 | 177 | 205 | 70 | 60 | 101 | 88 | 143 | 109 |
| 11 | 86 | | 111 | | 193 | | 86 | | 128 | | 129 | |
| 12 | 116 | | 118 | | 192 | | 68 | | 111 | | 102 | |
| 14 | 121 | | 112 | | 230 | | 87 | | 90 | | 161 | |
| 15 | 95 | | 124 | | 163 | | 125 | | 112 | | 120 | |
| $\bar{\mu}$ | 111 | 106 | 117 | 114 | 194 | 227 | 85 | 79 | 105 | 91 | 137 | 120 |
| 10 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| 17 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| $\bar{\mu}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | | 0 | | 13 | | 11 | | 27 | | 0 | | 20 |
| 12 | | 0 | | 29 | | 14 | | 13 | | 0 | | 25 |
| 21 | 0 | | 13 | | 11 | | 18 | | 0 | | 20 | |
| 22 | 0 | | 15 | | 12 | | 19 | | 0 | | 25 | |
| $\bar{\mu}$ | 0 | 0 | 14 | 21 | 12 | 12 | 19 | 20 | 0 | 0 | 23 | 23 |

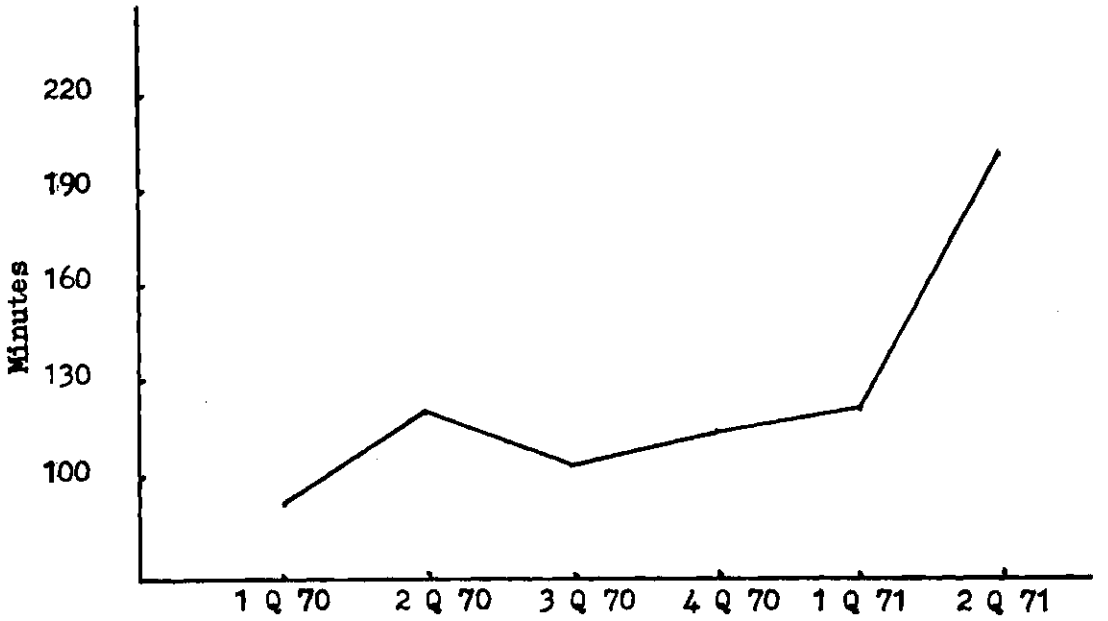
## Experiment 3

The objective of experiment number three is to determine if the designed organization, organization No. 2, can accommodate high amounts of input. This experiment is felt to be necessary because in previous experiments, the mean quarterly input was used. In this experiment, the highest input experienced in each group of transactions during a quarter, will be used. This creates input that exceeds any total monthly input that was actually experienced. Again, as in the two previous experiments, the monthly transactions will be eliminated, in order to get a response from only the random daily transactions.

Figures 35 through 39 and Table 9 show the responses of organization No. 2 to the extreme loading. In all cases, with the exception of processing during the fourth quarter of 1970, the organization was able to meet the established standards. In the case of processing, the situation which occurred was discussed during the design of the organization in Chapter III. The AG would have to take special action to establish processing teams from all of his assets, to cope with the situation.

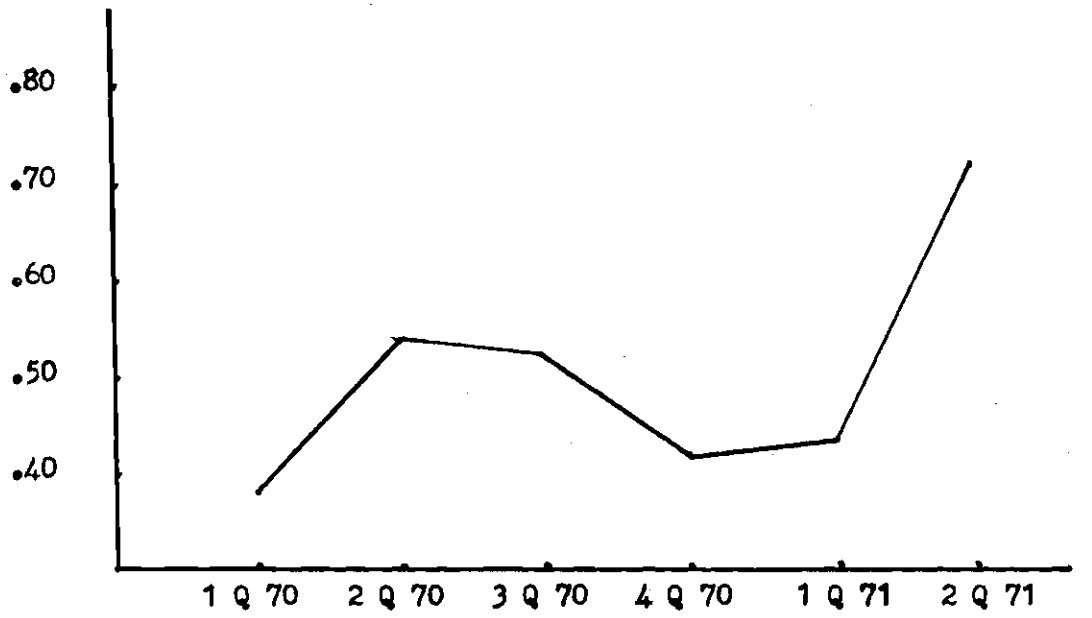



Facility Utilization

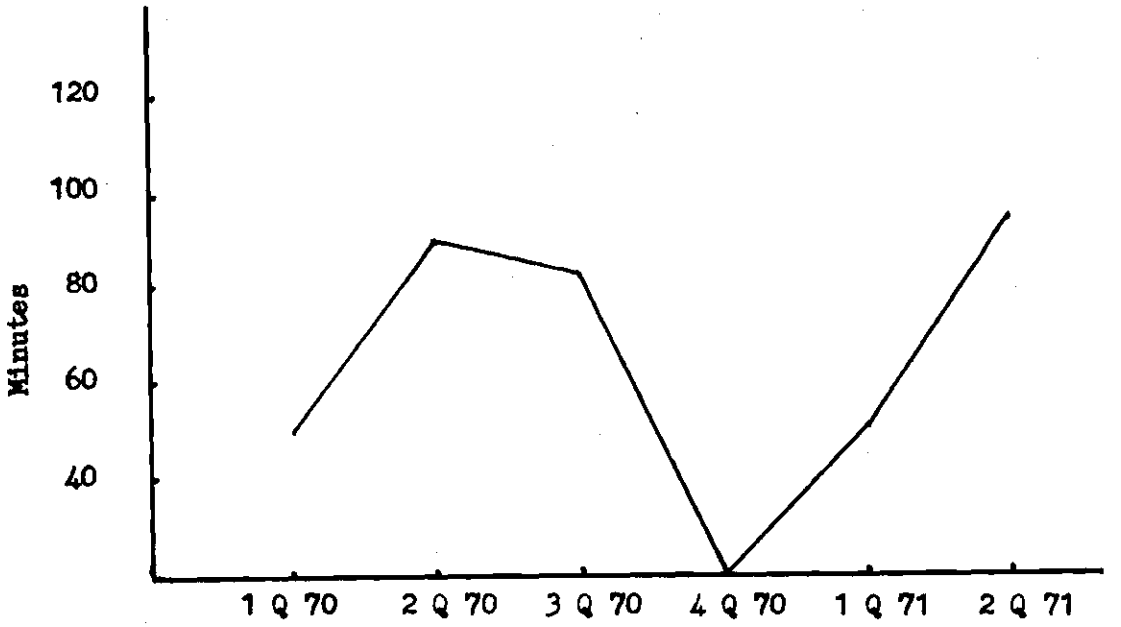



Queue Delay

Figure 35. Personnel Management - Organization 2

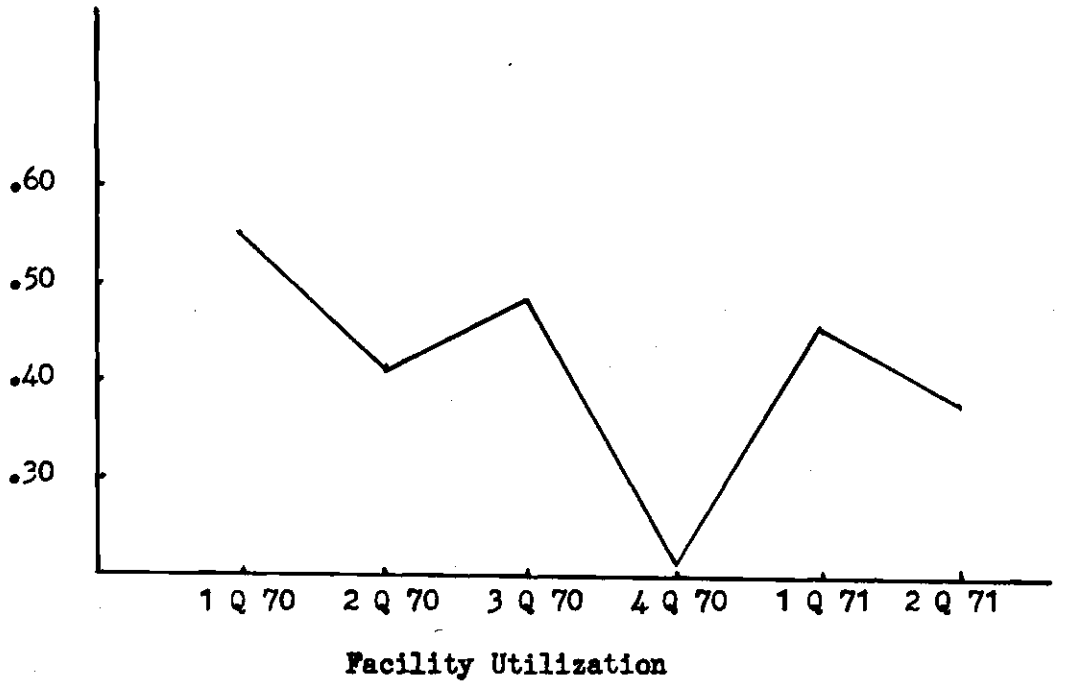



Facility Utilization




Queue Delay

Figure 36. Personnel Actions - Organization 2



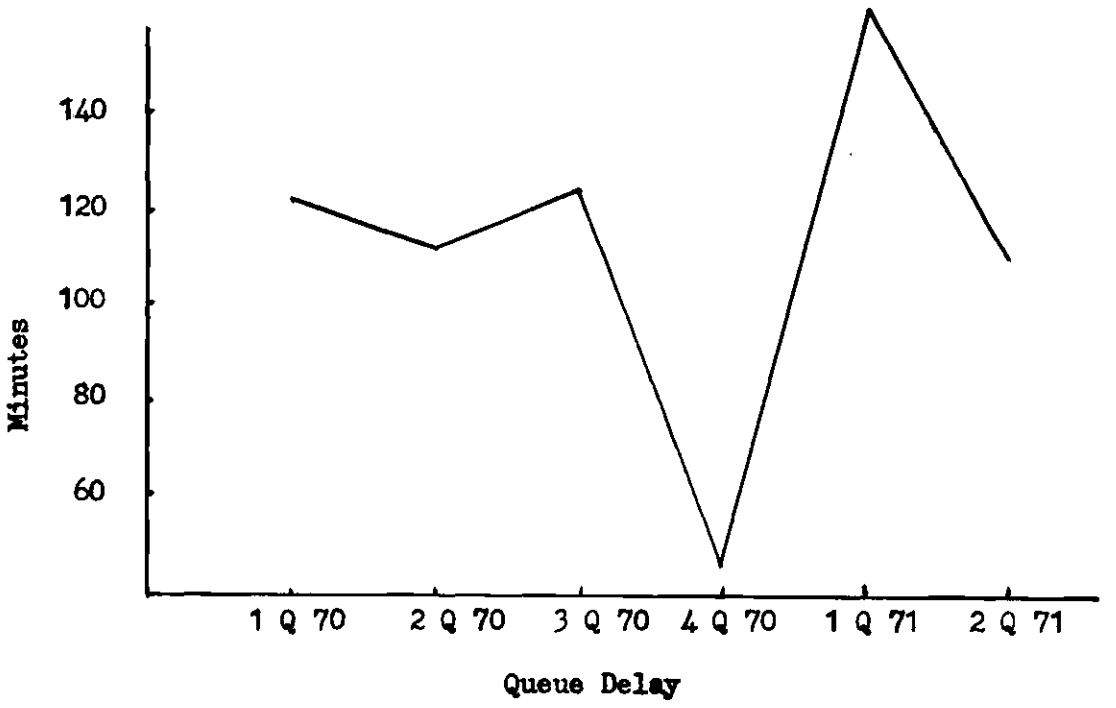
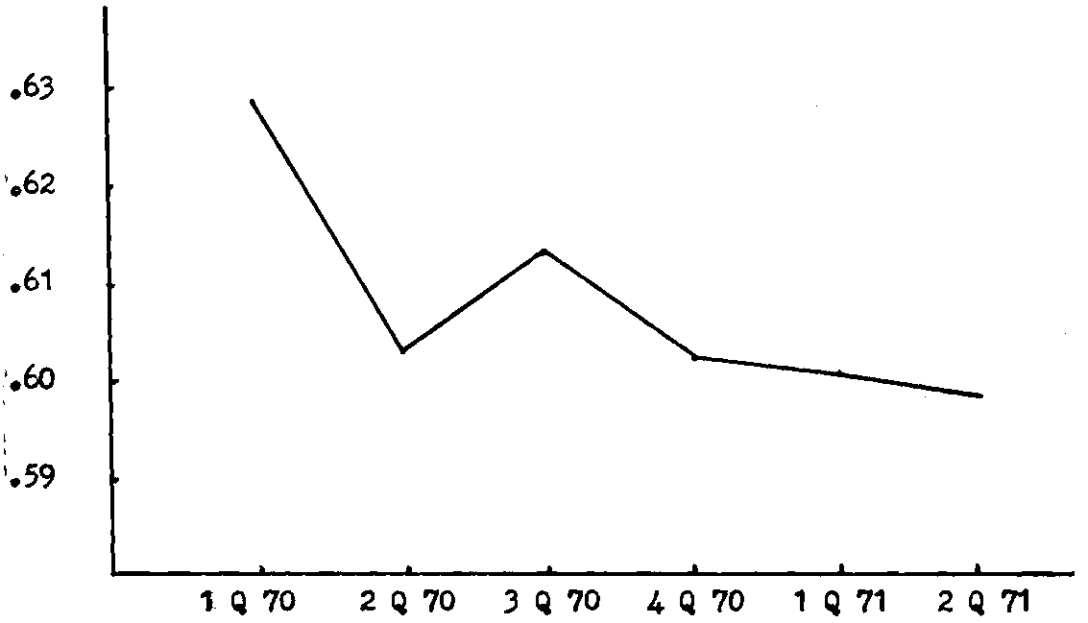
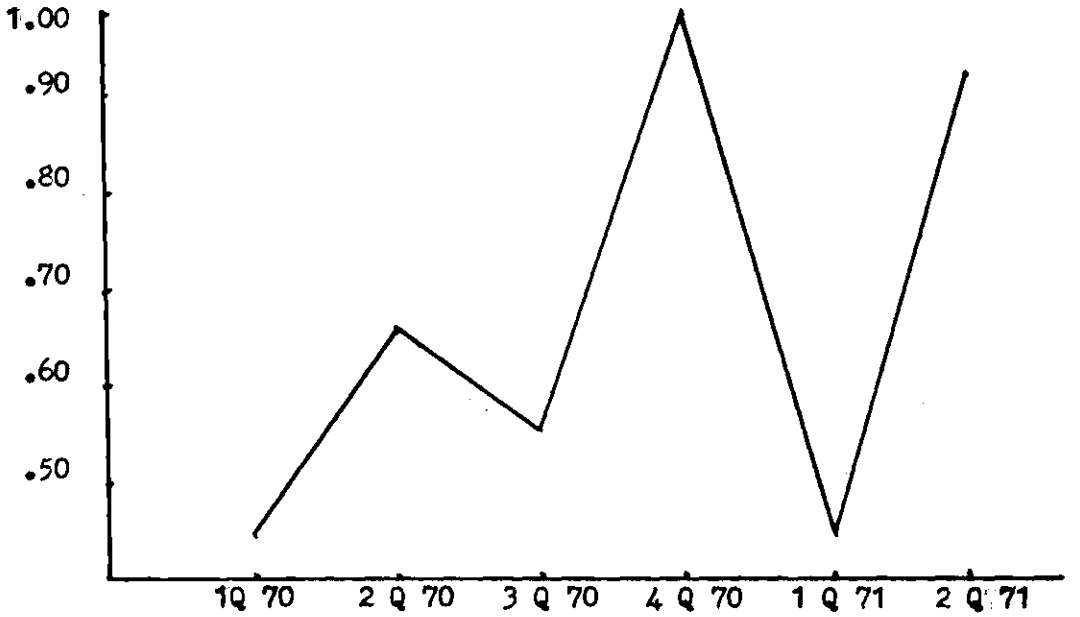




Figure 37. Personnel Records - Organization 2

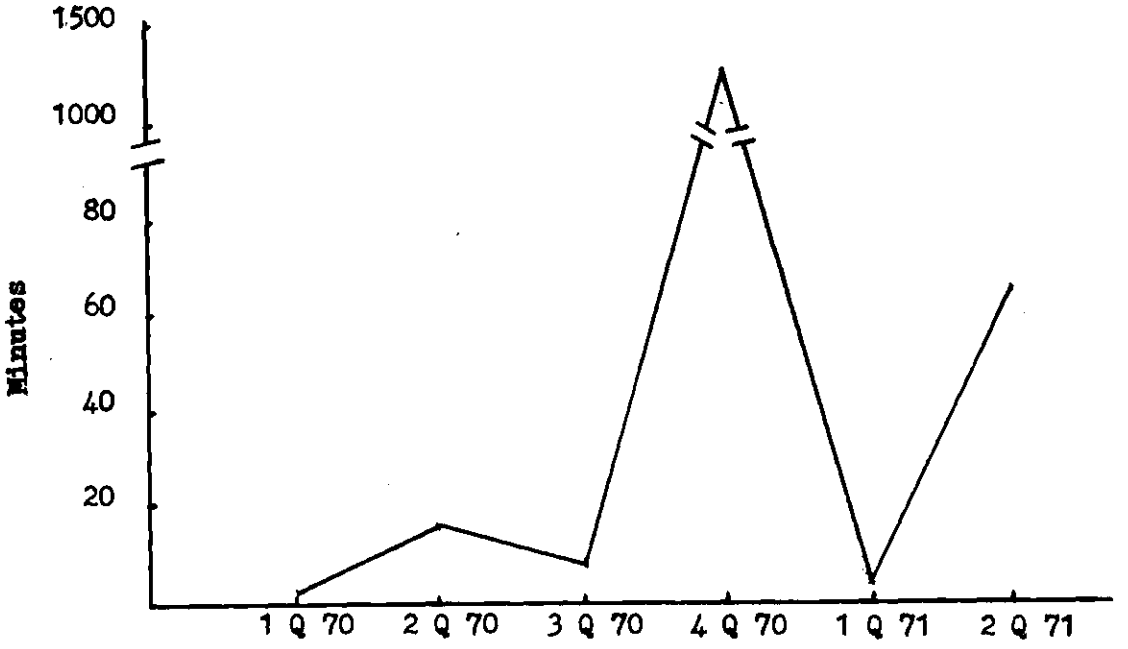



No transactions were delayed.

Figure 38. Reports - Organization 2




Facility Utilization




Queue Delay

Figure 39. Processing - Organization 2

Table 9. Organization No. 2 Experiment No. 3

| Facility Number | 1Q70 FAC | 1Q70 Q | 2Q70 FAC | 2Q70 Q | 3Q70 FAC | 3Q70 Q | 4Q70 FAC | 4Q70 Q | 1Q71 FAC | 1Q71 Q | 2Q71 FAC | 2Q71 Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .2454 | 85 | .1717 | 39 | .2293 | 28 | .2142 | 76 | .1845 | 54 | .3191 | 84 |
| 2 | .3305 | 105 | .4187 | 98 | .3106 | 106 | .5345 | 104 | .4617 | 111 | .7894 | 290 |
| 3 | .2510 | 73 | .4728 | 185 | .3774 | 135 | .3693 | 136 | .5307 | 158 | .7587 | 185 |
| $\bar{\mu}$ | .2816 | 88 | .3909 | 121 | .3210 | 102 | .4043 | 111 | .4338 | 118 | .6830 | 207 |
| 4 | .3019 | 19 | .4296 | 53 | .4065 | 46 | .3192 | 8 | .3695 | 46 | .6321 | 99 |
| 5 | .4063 | 70 | .6055 | 109 | .5903 | 101 | .4554 | 26 | .4553 | 55 | .7414 | 92 |
| $\bar{\mu}$ | .3715 | 51 | .5468 | 90 | .5290 | 82 | .4100 | 20 | .4267 | 52 | .7049 | 94 |
| 6 | .5563 | 123 | .4094 | 107 | .4936 | 132 | .2315 | 44 | .4645 | 151 | .3836 | 93 |
| 7 | .5583 | 130 | .4050 | 113 | .4864 | 106 | .1857 | 49 | .4677 | 182 | .4018 | 99 |
| 8 | .5586 | 116 | .4093 | 104 | .4672 | 149 | .1934 | 54 | .4587 | 167 | .3703 | 122 |
| 9 | .5513 | 119 | .4118 | 129 | .4999 | 106 | .2192 | 43 | .4671 | 154 | .3913 | 128 |
| $\bar{\mu}$ | .5561 | 122 | .4088 | 113 | .4867 | 123 | .2074 | 48 | .4637 | 164 | .3867 | 110 |
| 10 | .6271 | 0 | .6029 | 0 | .6133 | 0 | .6017 | 0 | .6000 | 0 | .5987 | 0 |
| $\bar{\mu}$ | .6271 | 0 | .6029 | 0 | .6133 | 0 | .6017 | 0 | .6000 | 0 | .5987 | 0 |
| 11 | .4433 | 2 | .6675 | 15 | .5569 | 7 | .9956 | 1035 | .4562 | 2 | .9048 | 57 |
| 12 | .4433 | 2 | .6447 | 15 | .5510 | 8 | .9999 | 1453 | .4489 | 3 | .9302 | 74 |
| $\bar{\mu}$ | .4433 | 2 | .6561 | 15 | .5539 | 8 | .9977 | 1244 | .4525 | 3 | .9175 | 65 |

# CHAPTER VI

# CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

1. The methodology presented in Chapter III can develop an organization for a composite team which is 26 percent smaller in direct-worker personnel than the one proposed by Department of the Army, yet can perform its mission within the limits of the performance standards established for both organizations. When the complete organization including supervisory personnel is considered, there is a 35 percent reduction with the designed organization. Therefore, the methodology contained in this paper is considered to develop more economical organizations than the procedure now in use by Department of the Army.

2. GPSS II simulation is a good method of testing and evaluating administrative organizations to determine their response to varying loads. Administrative organizations such as a composite team lend themselves to simulation by GPSS II, because they are composed of a series of queues and facilities and the language is uniquely suited to this type of simulation.

## Limitations

1. No attempt has been made to optimize the organization or to determine the maximum capacity of the designed organization.

2. The methodology developed in this paper would be

useless in situations where procedures are not well-defined and adequate historical data are available.

3. The current structure of GPSS II may place restrictions on the size of administrative organizations that can be simulated, and the number of transactions within the system.

## Recommendations

1. The methodology presented in Chapter III be used to develop designs for administrative organizations in government or the military where procedures are well-defined and massive historical data are available.

2. GPSS II simulation be used to test the effectiveness of designs for administrative organizations prior to implementation of these designs.

# APPENDIX A

## DATA FOR RANDOM DAILY TRANSACTIONS

| TRANSACTION NUMBER | | JAN | | FEB | | MAR | | 1ST QTR 70 | | APR | | MAY | | JUN | | 2ND QTR 70 | | JUL | | AUG | | SEP | | 3RD QTR 70 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % |
| 16 | M | 88 | 9.50 | 1.50 | 11.00 | .27 | 3.50 | .88 | 8.00 | 1.08 | 8.00 | .98 | 6.50 | .37 | 1.50 | .81 | 5.33 | .81 | 4.50 | 2.08 | 12.50 | 2.94 | 12.50 | 1.94 | 9.80 |
| 23 | M | 4.69 | 19.00 | 6.69 | 50.50 | 6.59 | 72.50 | 5.99 | 57.30 | 8.07 | 64.00 | 7.67 | 51.00 | 11.27 | 58.00 | 9.00 | 57.66 | 10.13 | 63.50 | 9.82 | 57.50 | 14.86 | 67.50 | 11.66 | 62.80 |
| 48 | A | .27 | 3.00 | .06 | .50 | .54 | 6.50 | .29 | 3.33 | 1.08 | 8.00 | .76 | 5.00 | 1.96 | 10.50 | 1.26 | 7.90 | 1.35 | 8.00 | 1.04 | 6.50 | – | – | .79 | 4.80 |
| 46 | A | 3.63 | 39.00 | 3.61 | 38.50 | 1.69 | 18.00 | 2.97 | 31.83 | 2.95 | 21.00 | 5.70 | 37.00 | 5.63 | 29.50 | 4.77 | 29.16 | 3.78 | 23.50 | 4.16 | 24.50 | 4.41 | 20.00 | 4.11 | 22.66 |
| TOTAL | | 9.48 | | 13.39 | | 9.06 | | 10.64 | | 13.18 | | 15.13 | | 19.24 | | 15.85 | | 16.08 | | 17.11 | | 22.22 | | 18.47 | |
| 33 | A | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 34 | A | 5.31 | 13.00 | 4.81 | 10.00 | 4.76 | 11.50 | 4.96 | 11.50 | 6.88 | 13.00 | 8.00 | 18.50 | 8.82 | 19.00 | 7.90 | 16.80 | 6.08 | 16.00 | 9.52 | 23.00 | 15.84 | 26.50 | 10.48 | 21.80 |
| 41 | A | 30.14 | 75.00 | 33.77 | 71.00 | 25.82 | 64.50 | 29.91 | 70.10 | 34.05 | 64.00 | 27.40 | 62.50 | 32.10 | 64.50 | 31.18 | 63.66 | 25.67 | 66.00 | 25.44 | 62.50 | 37.58 | 64.00 | 29.56 | 64.16 |
| 49 | A | .27 | .50 | .47 | .50 | .72 | 2.00 | .55 | 1.00 | .68 | 1.00 | .54 | 1.50 | 1.47 | 3.50 | .89 | 2.00 | .67 | 2.00 | .44 | 1.00 | .49 | .50 | .53 | 1.16 |
| 25 | M | 4.43 | 11.50 | 8.67 | 18.00 | 8.60 | 21.50 | 7.23 | 17.00 | 11.12 | 21.00 | 6.68 | 15.50 | 6.74 | 13.00 | 8.18 | 16.50 | 6.08 | 16.00 | 4.90 | 12.00 | 4.41 | 8.00 | 5.13 | 12.00 |
| 4 | M | – | – | .09 | – | .09 | – | .06 | – | – | – | .10 | .50 | .24 | .50 | .11 | .33 | – | – | .14 | .50 | – | – | .04 | .16 |
| 12 | M | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 13 | M | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 18 | M | – | – | – | – | .09 | – | .03 | – | .49 | 1.00 | .87 | 2.00 | 1.10 | 2.00 | .82 | 1.66 | .27 | .50 | – | – | – | – | .09 | .33 |
| TOTAL | | 40.15 | | 47.83 | | 40.89 | | 42.95 | | 53.24 | | 43.64 | | 50.99 | | 49.12 | | 39.05 | | 40.48 | | 58.33 | | 45.92 | |
| 9 | M | .08 | 2.00 | .09 | 2.50 | .18 | 4.50 | .12 | 3.00 | .20 | 2.00 | .10 | 1.00 | .24 | 2.50 | .18 | 1.80 | .13 | 1.50 | .14 | 2.50 | .49 | 4.50 | .25 | 2.83 |
| 14 | M | 2.74 | 47.50 | 2.64 | 38.50 | 1.09 | 20.50 | 2.15 | 35.50 | 2.46 | 27.50 | 2.63 | 22.50 | 1.34 | 12.50 | 2.14 | 20.80 | 1.48 | 18.00 | 2.67 | 30.00 | 7.35 | 68.50 | 3.83 | 38.83 |
| 44 | A | 1.06 | 20.00 | 1.03 | 19.00 | 1.09 | 22.50 | 1.06 | 20.50 | 3.24 | 38.50 | 6.90 | 56.50 | 4.77 | 44.50 | 4.97 | 46.50 | 4.86 | 59.50 | 4.00 | 48.00 | 1.79 | 16.00 | 3.85 | 41.16 |
| 45 | A | .08 | 1.50 | .18 | 2.50 | .64 | 12.50 | .30 | 5.50 | .78 | 9.50 | .98 | 7.50 | 1.96 | 19.50 | 1.24 | 12.10 | .40 | 4.50 | .29 | 5.00 | – | – | .23 | 3.16 |
| 17 | M | 1.06 | 21.50 | 1.41 | 27.00 | .82 | 16.50 | 1.09 | 21.66 | .68 | 8.00 | .54 | 4.50 | .49 | 5.00 | .57 | 5.80 | .27 | 3.00 | – | – | – | – | .09 | 1.00 |
| 40 | A | .44 | 7.50 | .66 | 11.00 | 1.09 | 23.00 | .73 | 13.83 | 1.27 | 14.50 | .87 | 7.00 | 1.47 | 15.00 | 1.20 | 12.10 | 1.08 | 13.00 | 1.33 | 19.50 | 1.14 | 10.50 | 1.18 | 12.66 |
| TOTAL | | 5.49 | | 6.03 | | 4.90 | | 5.47 | | 8.66 | | 12.06 | | 10.29 | | 10.38 | | 8.24 | | 8.48 | | 10.78 | | 9.16 | |
| 3 | M | – | – | .09 | 10.00 | – | – | .03 | 3.30 | – | – | – | – | – | – | – | – | .40 | 25.00 | .44 | 32.50 | .16 | 25.00 | .33 | 27.50 |
| 5 | M | .17 | 75.00 | .18 | 20.00 | .09 | 16.60 | .14 | 37.16 | .29 | 13.50 | .10 | 25.00 | .49 | 66.00 | .29 | 34.80 | 1.08 | 16.00 | .41 | 30.00 | .49 | 45.00 | .67 | 30.50 |
| 8 | M | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 11 | M | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 36 | A | – | – | .18 | 35.00 | .09 | 50.00 | .09 | 28.33 | .19 | 29.50 | .21 | 50.00 | .12 | 16.50 | .17 | 32.00 | – | – | – | – | – | – | – | – |
| 38 | A | .08 | 25.00 | .18 | 35.00 | .18 | 33.33 | .14 | 31.00 | .78 | 56.50 | .10 | 25.00 | .12 | 16.50 | .33 | 32.60 | .13 | 8.50 | .44 | 37.50 | .49 | 30.00 | .35 | 25.50 |
| TOTAL | | .26 | | .66 | | .36 | | .42 | | 1.27 | | .43 | | .73 | | .81 | | .81 | | 1.33 | | 1.14 | | 1.09 | |
| 54 | R | 88 | 12.00 | 1.41 | 16.50 | 1.09 | 12.00 | 1.12 | 13.50 | .98 | 8.00 | 1.97 | 24.50 | 3.06 | 20.00 | 2.00 | 17.50 | 2.70 | 22.50 | 1.48 | 15.00 | 1.47 | 11.00 | 1.88 | 16.16 |
| 32 | A | 5.76 | 78.50 | 6.41 | 75.00 | 6.13 | 67.00 | 6.10 | 73.50 | 8.36 | 73.50 | 4.49 | 46.00 | 9.06 | 60.00 | 7.30 | 63.16 | 7.70 | 65.00 | 7.44 | 74.50 | 9.80 | 61.50 | 8.31 | 70.33 |
| 47 | A | .35 | 4.50 | .37 | 4.50 | 1.09 | 12.00 | .60 | 7.00 | .59 | 4.50 | .65 | 8.00 | 1.34 | 9.00 | .86 | 7.16 | .81 | 7.00 | .44 | 4.50 | 1.30 | 9.50 | .85 | 7.00 |
| 37 | A | .35 | 4.50 | .37 | 4.50 | .82 | 9.00 | .51 | 5.83 | 1.37 | 13.00 | .87 | 11.00 | 1.71 | 11.50 | 1.31 | 11.80 | .67 | 6.00 | .59 | 5.50 | 1.14 | 7.50 | .80 | 6.33 |
| TOTAL | | 7.35 | | 8.50 | | 9.15 | | 8.33 | | 11.31 | | 8.00 | | 15.19 | | 11.50 | | 11.80 | | 9.97 | | 13.72 | | 11.83 | |
| 53 | R | 2.03 | 54.00 | 1.22 | 23.00 | 1.19 | 20.50 | 1.48 | 32.50 | 1.18 | 23.00 | 1.42 | 32.00 | 3.06 | 46.00 | 1.88 | 33.60 | .94 | 13.50 | 2.08 | 33.50 | 2.61 | 39.50 | 1.87 | 28.83 |
| 15 | M | 1.41 | 40.50 | 3.58 | 63.50 | 2.74 | 48.00 | 2.57 | 50.66 | 2.36 | 52.00 | 2.41 | 55.00 | 1.34 | 20.50 | 2.03 | 43.40 | 10.00 | 68.00 | 2.08 | 33.50 | 2.28 | 38.50 | 4.78 | 47.50 |
| 39 | A | – | – | .09 | 3.00 | .45 | 9.00 | .18 | 4.00 | .09 | 1.50 | .10 | 3.00 | .36 | 6.50 | .18 | 3.66 | .13 | 1.50 | .29 | 4.00 | .16 | 4.00 | .36 | 3.16 |
| 35 | A | .17 | 5.00 | .66 | 12.00 | 1.19 | 22.00 | .67 | 13.00 | .78 | 18.50 | .43 | 10.50 | 1.83 | 28.00 | 1.01 | 19.00 | 1.08 | 17.00 | 1.63 | 26.50 | 1.14 | 18.00 | 1.28 | 20.50 |
| TOTAL | | 3.45 | | 5.54 | | 5.58 | | 4.86 | | 4.42 | | 4.38 | | 6.61 | | 5.13 | | 7.29 | | 6.10 | | 6.20 | | 6.53 | |

| TRANSACTION NUMBER | | OCT | | NOV | | DEC | | 4TH QTR 10 | | JAN | | FEB | | MAR | | 1ST QTR 11 | | APR | | MAY | | JUN | | 2ND QTR 11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % |
| 16 | M | .89 | 6.00 | .81 | 7.50 | .34 | 2.50 | .68 | 5.33 | 1.14 | 10.00 | 1.09 | 12.50 | 3.34 | 31.00 | 1.85 | 12.80 | 1.69 | 13.00 | 2.10 | 12.50 | 1.93 | 11.50 | 1.90 | 12.33 |
| 23 | M | 11.37 | 66.50 | 9.57 | 83.00 | 6.65 | 65.00 | 9.20 | 71.50 | 6.36 | 61.50 | 6.31 | 73.00 | 5.31 | 50.50 | 5.99 | 61.60 | 9.32 | 66.50 | 11.44 | 68.00 | 13.67 | 76.50 | 11.47 | 70.33 |
| 48 | A | .59 | 4.00 | .54 | 4.50 | 1.37 | 16.50 | .83 | 8.33 | .85 | 7.50 | .45 | 5.50 | .49 | 5.00 | .59 | 6.00 | .84 | 5.50 | .70 | 4.00 | .55 | 3.00 | .69 | 4.16 |
| 46 | A | 4.34 | 23.50 | .54 | 4.50 | 1.37 | 16.50 | 2.08 | 14.66 | 2.18 | 21.50 | .82 | 9.50 | 1.37 | 13.50 | 1.45 | 14.80 | 2.11 | 15.00 | 2.57 | 15.00 | 1.38 | 8.00 | 2.02 | 12.46 |
| TOTAL | | 17.21 | | 11.48 | | 9.74 | | 12.81 | | 10.55 | | 8.69 | | 10.53 | | 9.92 | | 13.98 | | 16.82 | | 17.54 | | 16.11 | |
| 33 | A | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 34 | A | 7.33 | 18.00 | 5.67 | 20.00 | 5.96 | 21.00 | 6.32 | 19.66 | 6.27 | 18.50 | 7.05 | 25.50 | 5.41 | 17.50 | 6.24 | 20.50 | 6.03 | 18.50 | 7.12 | 21.00 | 9.53 | 21.00 | 7.56 | 20.10 |
| 41 | A | 29.04 | 73.00 | 20.81 | 70.50 | 22.24 | 72.00 | 24.03 | 71.80 | 22.52 | 65.00 | 17.85 | 61.00 | 20.57 | 65.50 | 20.31 | 63.80 | 20.44 | 59.50 | 19.15 | 55.00 | 25.82 | 52.50 | 21.80 | 57.00 |
| 49 | A | .14 | .50 | .13 | .50 | .45 | 1.50 | .24 | .83 | .28 | 1.00 | .73 | 2.50 | .59 | 2.00 | .53 | 2.00 | .63 | 2.00 | .58 | 2.00 | .69 | 1.50 | .63 | 1.83 |
| 25 | M | 2.84 | 7.50 | 2.29 | 8.00 | 2.63 | 5.50 | 2.58 | 7.00 | 4.46 | 13.00 | 3.29 | 10.50 | 3.34 | 11.00 | 3.69 | 11.50 | 5.61 | 17.00 | 4.78 | 14.50 | 7.32 | 17.00 | 5.90 | 16.10 |
| 4 | M | .14 | .50 | .13 | .50 | - | - | .09 | .33 | .09 | .50 | .09 | .05 | .29 | 1.00 | .15 | .66 | .21 | 1.00 | .23 | 1.00 | .27 | 1.00 | .23 | 1.00 |
| 12 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 18 | M | .29 | 1.00 | .27 | 1.00 | - | - | .18 | .66 | .57 | 1.50 | .27 | 1.50 | 1.08 | 3.50 | .64 | 2.16 | .84 | 2.50 | 2.68 | 7.00 | 1.79 | 3.50 | 1.77 | 4.33 |
| TOTAL | | 31.82 | | 29.32 | | 31.30 | | 33.48 | | 34.22 | | 29.30 | | 31.29 | | 31.60 | | 33.79 | | 34.57 | | 45.44 | | 37.93 | |
| 9 | M | .14 | 3.50 | .27 | 4.00 | .11 | 2.50 | .87 | 3.33 | .09 | 1.00 | .09 | 1.00 | .19 | 1.50 | .12 | 1.16 | .21 | 1.00 | .11 | .50 | .27 | 2.50 | .19 | 1.33 |
| 14 | M | 1.94 | 43.50 | 1.35 | 23.00 | .57 | 2.00 | 1.28 | 22.83 | 1.90 | 19.50 | .73 | 8.00 | 1.96 | 15.00 | 1.53 | 14.10 | 1.48 | 8.50 | .93 | 4.50 | 2.07 | 16.50 | 1.49 | 9.80 |
| 44 | A | 1.01 | 23.00 | 3.91 | 55.00 | 6.65 | 52.50 | 3.85 | 93.50 | 4.65 | 48.50 | 5.67 | 55.00 | 5.80 | 44.00 | 5.37 | 49.10 | 7.62 | 43.50 | 10.16 | 50.00 | 6.76 | 45.00 | 8.18 | 46.10 |
| 45 | A | - | - | - | - | .11 | .50 | .03 | .16 | .76 | 8.00 | 1.19 | 12.00 | 3.74 | 28.00 | 1.89 | 16.00 | 5.82 | 33.00 | 4.67 | 23.50 | 3.30 | 23.50 | 4.59 | 26.10 |
| 17 | M | - | - | .27 | 4.00 | - | - | .09 | 1.33 | 1.04 | 11.00 | 1.19 | 12.00 | .49 | 3.50 | .90 | 8.30 | .52 | 3.00 | .46 | 2.00 | .27 | 1.50 | .41 | 2.16 |
| 40 | A | 1.34 | 30.00 | .94 | 13.50 | 9.28 | 42.50 | 3.85 | 28.66 | 1.14 | 12.00 | 1.46 | 14.00 | 1.08 | 8.00 | 1.22 | 11.30 | 1.90 | 10.50 | 4.26 | 19.00 | 1.65 | 12.00 | 2.58 | 13.80 |
| TOTAL | | 4.46 | | 6.75 | | 16.74 | | 9.31 | | 9.60 | | 10.34 | | 13.28 | | 11.07 | | 17.58 | | 20.56 | | 14.36 | | 17.50 | |
| 3 | M | .41 | 37.50 | .40 | 21.50 | - | - | .28 | 29.66 | - | - | - | - | .19 | 21.00 | .06 | 7.00 | - | - | - | - | .27 | 9.00 | .09 | 3.00 |
| 5 | M | .14 | 17.50 | .13 | 7.00 | .11 | 14.00 | .12 | 8.83 | .19 | 25.00 | .09 | 25.00 | .59 | 58.50 | .29 | 36.00 | .52 | 24.50 | .23 | 13.50 | .96 | 31.50 | .57 | 23.16 |
| 8 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 36 | A | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .31 | 10.50 | - | - | .27 | 9.00 | .19 | 6.50 |
| 38 | A | .14 | 50.00 | 1.08 | 71.50 | .68 | 86.00 | .63 | 59.83 | .66 | 75.00 | .45 | 75.00 | .19 | 21.00 | .45 | 57.00 | 1.16 | 65.00 | 1.57 | 86.50 | 1.81 | 50.00 | 1.39 | 67.16 |
| TOTAL | | .69 | | 1.62 | | .80 | | 1.05 | | .85 | | .54 | | .98 | | .79 | | 2.01 | | 2.21 | | 2.90 | | 2.37 | |
| 54 | R | 2.69 | 22.50 | 2.16 | 24.00 | .57 | 7.00 | 1.80 | 17.83 | .95 | 8.50 | 1.46 | 10.00 | 1.18 | 9.00 | 1.19 | 9.14 | 1.16 | 6.50 | 1.40 | 9.00 | 1.57 | 8.00 | 1.35 | 7.83 |
| 32 | A | 7.33 | 60.50 | 5.67 | 64.00 | 5.96 | 74.00 | 6.32 | 66.16 | 8.55 | 77.00 | 11.44 | 79.50 | 10.03 | 78.00 | 10.00 | 78.16 | 16.10 | 86.50 | 12.85 | 85.50 | 16.71 | 85.00 | 15.22 | 85.60 |
| 47 | A | 1.04 | 9.00 | .67 | 7.50 | .45 | 6.50 | .72 | 7.66 | 1.04 | 9.00 | .45 | 3.00 | .59 | 4.50 | .69 | 5.50 | 1.05 | 5.50 | .46 | 3.00 | .13 | 1.00 | .54 | 3.16 |
| 37 | A | 1.04 | 9.00 | .40 | 4.50 | .80 | 12.50 | .74 | 8.00 | .57 | 5.00 | 1.00 | 7.00 | 1.08 | 8.50 | .88 | 6.80 | .74 | 4.00 | .35 | 2.50 | 1.24 | 6.00 | .77 | 4.16 |
| TOTAL | | 12.12 | | 8.91 | | 7.79 | | 9.60 | | 11.12 | | 19.37 | | 12.89 | | 12.79 | | 19.06 | | 15.07 | | 19.61 | | 17.91 | |
| 53 | R | 1.49 | 41.50 | 1.62 | 43.50 | 1.14 | 34.50 | 1.41 | 39.83 | 1.42 | 45.00 | .91 | 29.50 | 1.47 | 20.50 | 1.26 | 31.66 | .84 | 19.00 | 1.98 | 22.50 | 3.72 | 22.00 | 2.18 | 22.83 |
| 15 | M | .89 | 25.00 | .67 | 18.00 | .80 | 31.50 | .78 | 24.83 | 1.61 | 46.50 | 1.37 | 44.50 | 4.72 | 67.00 | 2.52 | 52.46 | 2.33 | 47.00 | 5.60 | 63.50 | 6.90 | 54.00 | 4.94 | 54.80 |
| 39 | A | - | - | .13 | 3.50 | .22 | 5.00 | .11 | 2.83 | .09 | 2.50 | .09 | .30 | - | - | .06 | 1.80 | .40 | 3.00 | .11 | 1.50 | .27 | 2.50 | .19 | 2.33 |
| 35 | A | 1.19 | 32.50 | 1.35 | 35.00 | .91 | 29.50 | 1.15 | 32.33 | .19 | 6.50 | .73 | 23.50 | .98 | 13.00 | .63 | 14.30 | 1.69 | 31.50 | 1.16 | 13.50 | 2.34 | 16.50 | 1.73 | 20.50 |
| TOTAL | | 3.59 | | 3.78 | | 3.09 | | 3.48 | | 3.32 | | 3.11 | | 7.18 | | 4.53 | | 5.08 | | 8.87 | | 13.25 | | 9.06 | |

# APPENDIX B

## COMPUTER COMPILATION OF SIMULATION MODEL FOR DEPARTMENT OF THE ARMY ORGANIZATION

```
LOC   NAME        X       Y       Z       SEL     NBA     NBB     MEAN    MOD     REMARKS

      JOB         301741360741
* DATA 2 Q 71 V  N
* FUNCTIONS 1 THRU 6 ASSIGN PARAMETER 1 TO ALL TRANSACTIONS
 1    FUNCTION    RN1     D4
.1233 16    .8266 23    .9532 46    1.0   48
 2    FUNCTION    RN1     D9
.0023 4     .0024 12    .0025 13    .0458 18    .2068 25    .2069 33
.4079 34    .9817 41    1.0   49
 3    FUNCTION    RN1     D6
.0133 9     .1113 14    .1329 17    .2709 40    .7319 44    1.0   45
 4    FUNCTION    RN1     D6
.03   3     .2616 5     .2617 8     .2618 11    .3268 36    1.0   38
 5    FUNCTION    RN1     D4
.856  32    .8976 37    .9292 47    1.0   54
 6    FUNCTION    RN1     D4
.5480 15    .753  35    .7763 39    1.0   53
* FUNCTIONS 11 THRU 21 ASSIGN ACTION TIMES TO ALL TRANSACTIONS
 11   FUNCTION    RN1     D5
.2    3     .4    4     .6    5     .8    6     1.0   7
 12   FUNCTION    RN1     D5
.2    8     .4    9     .6    10    .8    11    1.0   12
 13   FUNCTION    RN1     D11
.0909 10    .1818 11    .2727 12    .3636 13    .4545 14    .5454 15
.6363 16    .7272 17    .8181 18    .9090 19    1.0   20
 14   FUNCTION    RN1     D11
.0909 25    .1818 26    .2727 27    .3636 28    .4545 29    .5454 30
.6363 31    .7272 32    .8181 33    .9090 34    1.0   35
 15   FUNCTION    RN1     D21
.0476 30    .0952 31    .1425 32    .1904 33    .238  34    .2857 35
.3333 36    .3809 37    .4285 38    .4761 39    .5238 40    .5714 41
.619  42    .6666 43    .7142 44    .7619 45    .8095 46    .8571 47
.9047 48    .9523 49    1.0   50
 17   FUNCTION    RN1     D25
.04   180   .08   185   .12   190   .16   195   .2    200   .24   205
.28   210   .32   215   .36   220   .4    225   .44   230   .48   235
.52   240   .56   245   .6    250   .64   255   .68   260   .72   265
.76   270   .8    275   .84   280   .88   285   .92   290   .96   295
1.0   300
 20   FUNCTION    RN1     D9
.0625 2000  .125  2200  .1875 2400  .25   2600  .75   2800  .8125 3000
.875  3200  .9375 3400  1.0   3600
 21   FUNCTION    RN1     D11
.05   10000 .1    10400 .15   10800 .2    11200 .25   11600 .75   12000
.8    12400 .85   12800 .9    13200 .95   13600 1.0   14000
 1    TABLE       P1      1     1     31
 2    TABLE       P1      1     1     31
 3    TABLE       P1      1     1     31
 5    TABLE       P1      31    1     20
 8    TABLE       P1      31    1     20
 6    TABLE       P1      1     1     63
 9    TABLE       P1      1     1     63
 11   TABLE       P1      1     1     63
 12   TABLE       P1      1     1     63
```

```
14    TABLE       P1    1     1     63
15    TABLE       P1    1     1     63
* GENERATORS 2,20,50,80,110,130,210 DETERMINE THE INPUT DATA
2     GENERATE    1                       4           124   12
20    GENERATE    1                       22          53    5
50    GENERATE    1                       52          114   11
80    GENERATE    1                       82          844   84
110   GENERATE    1                       112         112   11
130   GENERATE    1                       132         221   22
210   GENERATE    1                       212         21    2
* BLOCKS 4 THRU 214 ASSIGN ALL PARAMETERS TO TRANSACTIONS
* AND SIMULATES THE INPUT INTO THE SYSTEM
4     ASSIGN      1     FN1                 6
6     ASSIGN      3     FN11        BOTH    8     10
8     COMPARE     P1    E     K46           12
10    ADVANCE                               240
12    ASSIGN      4     FN11                14
14    ASSIGN      6     FN20                240
22    ASSIGN      1     FN2                 24
24    ASSIGN      3     FN12        ALL     26    29
26    COMPARE     P1    LE    K18           30
27    COMPARE     P1    E     K25           29
28    COMPARE     P1    LE    K46           240
29    ASSIGN      4     FN11                34
30    ASSIGN      4     FN12                32
32    ASSIGN      6     FN21                240
34    ASSIGN      6     FN21                240
52    ASSIGN      1     FN3                 54
54    ASSIGN      3     FN13        ALL     56    58
56    COMPARE     P1    LE    K14           240
57    COMPARE     P1    LE    K40           60
58    ASSIGN      4     FN11                66
60    ASSIGN      4     FN12        BOTH    62    63
62    COMPARE     P1    E     K17           64
63    ASSIGN      6     FN20                240
64    ASSIGN      6     FN21                240
66    ASSIGN      6     FN20                240
82    ASSIGN      1     FN4                 84
84    ASSIGN      3     FN14        BOTH    86    87
86    COMPARE     P1    LE    K11           88
87    ASSIGN      4     FN13                92
88    ASSIGN      4     FN12                90
90    ASSIGN      6     FN21                240
92    ASSIGN      6     FN21                240
112   ASSIGN      1     FN5                 114
114   ASSIGN      3     FN15        ALL     115   117
115   COMPARE     P1    E     K32           240
116   COMPARE     P1    LE    K47           118
117   ADVANCE                               240
118   ASSIGN      4     FN12                120
120   ASSIGN      6     FN21                240
132   ASSIGN      1     FN6                 134
134   ASSIGN      3     FN17        ALL     136   138
136   COMPARE     P1    E     K15           140
137   COMPARE     P1    LE    K39           142
138   ADVANCE                               240
140   ASSIGN      2     K15                 250
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 142 | ASSIGN | 4 | FN13 | | | 144 | | |
| 144 | ASSIGN | 6 | FN20 | | | 240 | | |
| 152 | ADVANCE | | | | | 166 | | 4000 |
| 154 | ADVANCE | | | | | 166 | | 8000 |
| 156 | ADVANCE | | | | | 167 | | 6000 |
| 158 | ADVANCE | | | | | 167 | | 8000 |
| 162 | SPLIT | | | | | 164 | 181 | |
| 164 | SPLIT | | | | | 168 | 169 | |
| 166 | ASSIGN | 1 | K21 | | | 170 | | |
| 167 | ASSIGN | 1 | K22 | | | 171 | | |
| 168 | ASSIGN | 1 | K52 | | | 172 | | |
| 169 | ASSIGN | 1 | K58 | | | 173 | | |
| 170 | ASSIGN | 3 | K1200 | | | 240 | | |
| 171 | ASSIGN | 2 | K20 | | | 174 | | |
| 172 | ASSIGN | 3 | K800 | | | 596 | | |
| 173 | ASSIGN | 3 | FN13 | | | 240 | | |
| 174 | ASSIGN | 3 | FN17 | | | 176 | | |
| 176 | ASSIGN | 4 | K500 | | | 178 | | |
| 178 | ASSIGN | 6 | FN20 | | | 250 | | |
| 181 | ASSIGN | 1 | K10 | | | 182 | | |
| 182 | ASSIGN | 3 | K800 | | | 183 | | |
| 183 | ASSIGN | 2 | K10 | | | 184 | | |
| 184 | SPLIT | | | | | 596 | 250 | |
| 190 | GENERATE | 1 | | | | 192 | | 400 |
| 192 | SPLIT | | | | | 194 | 195 | |
| 194 | ASSIGN | 1 | K20 | | | 196 | | |
| 195 | ASSIGN | 1 | K59 | | | 198 | | |
| 196 | ASSIGN | 3 | FN17 | | | 250 | | |
| 198 | ASSIGN | 3 | FN17 | | | 620 | | |
| 212 | ASSIGN | 1 | K62 | | | 214 | | |
| 214 | ASSIGN | 3 | FN14 | | | 680 | | |
| 250 | ADVANCE | | | | ALL | 251 | 254 | |
| 251 | COMPARE | P1 | LE | K30 | | 300 | | |
| 252 | COMPARE | P1 | LE | K49 | | 400 | | |
| 253 | COMPARE | P1 | E | K53 | | 260 | | |
| 254 | ADVANCE | | | | PICK | 506 | 508 | |
| 260 | PRIORITY | 2 | | | | 261 | | |
| 261 | SPLIT | | | | | 262 | 265 | |
| 262 | SPLIT | | | | | 263 | 544 | |
| 263 | SPLIT | | | | | 512 | 522 | |
| 265 | SPLIT | | | | | 266 | 586 | |
| 266 | SPLIT | | | | | 554 | 576 | |
| 240 | ASSIGN | 2 | K1 | | | 250 | | |
| 596 | SPLIT | | | | | 533 | 534 | |
| 533 | SPLIT | | | | | 535 | 573 | |
| 534 | SPLIT | | | | | 574 | 536 | |
| 535 | SPLIT | | | | | 509 | 510 | |
| 536 | SPLIT | | | | | 541 | 542 | |
| 300 | ADVANCE | | | | PICK | 301 | 303 | |
| * PERSONNEL MANAGEMENT SPECIALIST | | | | | | | | |
| 301 | QUEUE | 1 | | | | 304 | | |
| 304 | SEIZE | 1 | | | | 306 | | |
| 306 | ADVANCE | | | | | 308 | | *2 |
| 308 | ADVANCE | | | | BOTH | 310 | 311 | *3 |
| 310 | COMPARE | P3 | GE | K1 | | 312 | | |
| 311 | ADVANCE | | | | | 312 | | *4 |
| 312 | RELEASE | 1 | | | | 313 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 313 | TABULATE | 1 | | | BOTH | 314 | 351 | | |
| 314 | COMPARE | P2 | GE | K1 | | 316 | | | |
| 316 | SPLIT | | | | | 504 | 351 | | |
| * PERSONNEL MANAGEMENT SPECIALIST | | | | | | | | | |
| 302 | QUEUE | 2 | | | | 320 | | | |
| 320 | SEIZE | 2 | | | | 322 | | | |
| 322 | ADVANCE | | | | | 324 | | *2 | |
| 324 | ADVANCE | | | | BOTH | 326 | 328 | *3 | |
| 326 | COMPARE | P3 | GE | K1 | | 330 | | | |
| 328 | ADVANCE | | | | | 330 | | *4 | |
| 330 | RELEASE | 2 | | | | 331 | | | |
| 331 | TABULATE | 2 | | | BOTH | 332 | 351 | | |
| 332 | COMPARE | P2 | GE | K1 | | 334 | | | |
| 334 | SPLIT | | | | | 504 | 351 | | |
| * PERSONNEL MANAGEMENT SPECIALIST | | | | | | | | | |
| 303 | QUEUE | 3 | | | | 336 | | | |
| 336 | SEIZE | 3 | | | | 338 | | | |
| 338 | ADVANCE | | | | | 340 | | *2 | |
| 340 | ADVANCE | | | | BOTH | 342 | 344 | *3 | |
| 342 | COMPARE | P3 | GE | K1 | | 346 | | | |
| 344 | ADVANCE | | | | | 346 | | *4 | |
| 346 | RELEASE | 3 | | | | 347 | | | |
| 347 | TABULATE | 3 | | | BOTH | 348 | 351 | | |
| 348 | COMPARE | P2 | GE | K1 | | 350 | | | |
| 350 | SPLIT | | | | | 504 | 351 | | |
| 351 | ADVANCE | | | | | 370 | | | |
| * SENIOR PERSONNEL MANAGEMENT SPECIALIST | | | | | | | | | |
| 370 | QUEUE | 4 | | | | 372 | | | |
| 372 | SEIZE | 4 | | | | 374 | | | |
| 374 | ADVANCE | | | | | 376 | | 5 | 2 |
| 376 | RELEASE | 4 | | | ALL | 378 | 380 | | |
| 378 | COMPARE | P1 | LE | K15 | | 382 | | | |
| 382 | SPLIT | | | | | 500 | 384 | | |
| 384 | ADVANCE | | | | BOTH | 386 | 388 | | |
| 386 | COMPARE | P6 | GE | K1 | | 470 | | | |
| 379 | COMPARE | P1 | LE | K22 | | 384 | | | |
| 380 | TERMINATE | | | | | | | | |
| 388 | TERMINATE | | | | | | | | |
| 470 | ADVANCE | | | | | 472 | | *6 | |
| 472 | ASSIGN | 3 | K0 | | | 474 | | | |
| 474 | ASSIGN | 6 | K0 | | | 250 | | | |
| 400 | ADVANCE | | | | PICK | 401 | 402 | | |
| * PERSONNEL ACTIONS SPECIALIST | | | | | | | | | |
| 401 | QUEUE | 5 | | | | 404 | | | |
| 404 | SEIZE | 5 | | | | 406 | | | |
| 406 | ADVANCE | | | | | 408 | | *2 | |
| 408 | ADVANCE | | | | BOTH | 410 | 412 | *3 | |
| 410 | COMPARE | P3 | GE | K1 | | 414 | | | |
| 412 | ADVANCE | | | | | 414 | | *4 | |
| 414 | RELEASE | 5 | | | | 415 | | | |
| 415 | TABULATE | 5 | | | BOTH | 416 | 436 | | |
| 416 | COMPARE | P2 | GE | K1 | | 418 | | | |
| 418 | SPLIT | | | | | 504 | 436 | | |
| * PERSONNEL ACTIONS SPECIALIST | | | | | | | | | |
| 402 | QUEUE | 6 | | | | 420 | | | |
| 420 | SEIZE | 6 | | | | 422 | | | |
| 422 | ADVANCE | | | | | 424 | | *2 | |

```
424  ADVANCE                          BOTH  426  428  *3
426  COMPARE   P3   GE   K1              430
428  ADVANCE                             430       *4
430  RELEASE   6                         431
431  TABULATE  6                      BOTH  432  436
432  COMPARE   P2   GE   K1              434
434  SPLIT                               504  436
436  QUEUE     7                         438
* SENIOR PERSONNEL ACTIONS SPECIALIST
438  SEIZE     7                         440
440  ADVANCE                             442       5    2
442  RELEASE   7                      BOTH  444  446
444  COMPARE   P1   E    K41             448
446  SPLIT                               500  448
448  ADVANCE                          BOTH  450  452
450  COMPARE   P6   GE   K1              470
452  TERMINATE
500  ASSIGN    3    FN11                502
502  ASSIGN    2    K0                  254
504  ASSIGN    3    K0                  254
506  ADVANCE                          PICK  509  510
507  ADVANCE                          PICK  573  574
508  ADVANCE                          PICK  541  542
* PERSONNNEL RECORDS
509  QUEUE     8                         512
512  SEIZE     8                         514
514  ADVANCE                             516       *2
516  ADVANCE                             518       *3
518  RELEASE   8                         519
519  TABULATE  8                         520
520  TERMINATE
* PERSONNEL RECORDS SPECIALTST
510  QUEUE     9                         522
522  SEIZE     9                         524
524  ADVANCE                             526       *2
526  ADVANCE                             528       *3
528  RELEASE   9                         529
529  TABULATE  9                         530
530  TERMINATE
* PERSONNEL RECORDS SPECIALTST
573  QUEUE     11                        576
576  SEIZE     11                        578
578  ADVANCE                             580       *2
580  ADVANCE                             582       *3
582  RELEASE   11                        583
583  TABULATE  11                        584
584  TERMINATE
* PERSONNEL RECORDS SPECIALTST
574  QUEUE     12                        586
586  SEIZE     12                        588
588  ADVANCE                             590       *2
590  ADVANCE                             592       *3
592  RELEASE   12                        593
593  TABULATE  12                        594
594  TERMINATE
* PERSONNEL RECORDS SPECIALTST
541  QUEUE     14                        544
```

```
544  SEIZE       14                    546
546  ADVANCE                           548          *2
548  ADVANCE                           550          *3
550  RELEASE     14                    551
551  TABULATE    14                    552
552  TERMINATE
* PERSONNEL RECORDS SPECIALIST
542  QUEUE       15                    554
554  SEIZE       15                    556
556  ADVANCE                           558          *2
558  ADVANCE                           560          *3
560  RELEASE     15                    561
561  TABULATE    15                    562
562  TERMINATE
* REPORTS SPECIALIST
620  ADVANCE                           621
621  QUEUE       17                    624
624  SEIZE       17                    626
626  ADVANCE                           628          *3
628  RELEASE     17                    630
630  TERMINATE
680  ADVANCE                  .5       681    682
* PROCESSING SPECIALIST
681  QUEUE       21                    684
684  SEIZE       21                    686
686  ADVANCE                           688          *3
688  RELEASE     21                    690
690  SPLIT                             500    692
* PROCESSING SPECIALIST
682  QUEUE       22                    694
694  SEIZE       22                    696
696  ADVANCE                           698          *3
698  RELEASE     22                    700
700  SPLIT                             500    692
692  TERMINATE
```

# APPENDIX C

## COMPUTER COMPILATION OF SIMULATION MODEL FOR DESIGNED ORGANIZATION

| LOC | NAME | X | Y | Z | SEL | NBA | NBB | MEAN | MOD | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | JOB | | 301741360741 | | | | | | | |
| * FUNCTIONS 1 THRU 6 ASSIGN PARAMETER 1 TO ALL TRANSACTIONS | | | | | | | | | | |
| * DATA 4 Q 70 V N | | | | | | | | | | |
| 1 | FUNCTION | | RN1 | D4 | | | | | | |
| .0533 | 16 | .7683 | 23 | .9149 | 46 | 1.0 | 48 | | | |
| 2 | FUNCTION | | RN1 | D9 | | | | | | |
| .0033 | 4 | .0034 | 12 | .0035 | 13 | .0101 | 18 | .0801 | 25 | .0802 33 |
| .2768 | 34 | .9917 | 41 | 1.0 | 49 | | | | | |
| 3 | FUNCTION | | RN1 | D6 | | | | | | |
| .0333 | 9 | .2616 | 14 | .2749 | 17 | .5615 | 40 | .9965 | 44 | 1.0 45 |
| 4 | FUNCTION | | RN1 | D6 | | | | | | |
| .1966 | 3 | .2849 | 5 | .285 | 8 | .2851 | 11 | .4651 | 36 | 1.0 38 |
| 5 | FUNCTION | | RN1 | D4 | | | | | | |
| .6616 | 32 | .7416 | 37 | .8182 | 47 | 1.0 | 54 | | | |
| 6 | FUNCTION | | RN1 | D4 | | | | | | |
| .2483 | 15 | .5716 | 35 | .5999 | 39 | 1.0 | 53 | | | |
| * FUNCTIONS 11 THRU 21 ASSIGN ACTION TIMES TO ALL TRANSACTIONS | | | | | | | | | | |
| 11 | FUNCTION | | RN1 | D5 | | | | | | |
| .2 | 3 | .4 | 4 | .6 | 5 | .8 | 6 | 1.0 | 7 | |
| 12 | FUNCTION | | RN1 | D5 | | | | | | |
| .2 | 8 | .4 | 9 | .6 | 10 | .8 | 11 | 1.0 | 12 | |
| 13 | FUNCTION | | RN1 | D11 | | | | | | |
| .0909 | 10 | .1818 | 11 | .2727 | 12 | .3636 | 13 | .4545 | 14 | .5454 15 |
| .6363 | 16 | .7272 | 17 | .8181 | 18 | .9090 | 19 | 1.0 | 20 | |
| 14 | FUNCTION | | RN1 | D11 | | | | | | |
| .0909 | 25 | .1818 | 26 | .2727 | 27 | .3636 | 28 | .4545 | 29 | .5454 30 |
| .6363 | 31 | .7272 | 32 | .8181 | 33 | .9090 | 34 | 1.0 | 35 | |
| 15 | FUNCTION | | RN1 | D21 | | | | | | |
| .0476 | 30 | .0952 | 31 | .1425 | 32 | .1904 | 33 | .238 | 34 | .2857 35 |
| .3333 | 36 | .3809 | 37 | .4285 | 38 | .4761 | 39 | .5239 | 40 | .5714 41 |
| .619 | 42 | .6666 | 43 | .7142 | 44 | .7619 | 45 | .8095 | 46 | .8571 47 |
| .9047 | 48 | .9523 | 49 | 1.0 | 50 | | | | | |
| 17 | FUNCTION | | RN1 | D25 | | | | | | |
| .04 | 180 | .08 | 185 | .12 | 190 | .16 | 195 | .2 | 200 | .24 205 |
| .28 | 210 | .32 | 215 | .36 | 220 | .4 | 225 | .44 | 230 | .48 235 |
| .52 | 240 | .56 | 245 | .6 | 250 | .64 | 255 | .68 | 260 | .72 265 |
| .76 | 270 | .8 | 275 | .84 | 280 | .88 | 285 | .92 | 290 | .96 295 |
| 1.0 | 300 | | | | | | | | | |
| 20 | FUNCTION | | RN1 | D9 | | | | | | |
| .0625 | 2000 | .125 | 2200 | .1875 | 2400 | .25 | 2600 | .75 | 2800 | .8125 3000 |
| .875 | 3200 | .9375 | 3400 | 1.0 | 3600 | | | | | |
| 21 | FUNCTION | | RN1 | D11 | | | | | | |
| .05 | 10000 | .1 | 10400 | .15 | 10800 | .2 | 11200 | .25 | 11600 | .75 12000 |
| .8 | 12400 | .85 | 12800 | .9 | 13200 | .95 | 13600 | 1.0 | 14000 | |
| 1 | TABLE | | P1 | 1 | 1 | 31 | | | | |
| 2 | TABLE | | P1 | 1 | 1 | 31 | | | | |
| 3 | TABLE | | P1 | 1 | 1 | 31 | | | | |
| 4 | TABLE | | P1 | 31 | 1 | 19 | | | | |
| 5 | TABLE | | P1 | 31 | 1 | 19 | | | | |
| 6 | TABLE | | P1 | 1 | 1 | 63 | | | | |
| 7 | TABLE | | P1 | 1 | 1 | 63 | | | | |
| 8 | TABLE | | P1 | 1 | 1 | 63 | | | | |
| 9 | TABLE | | P1 | 1 | 1 | 63 | | | | |

```
* GENERATORS 2,20,50,80,110,130,210 DETERMINE THE INPUT DATA
2     GENERATE    1                                  4          156   16
20    GENERATE    1                                  22         60    6
50    GENERATE    1                                  52         214   21
80    GENERATE    1                                  82         1905  191
110   GENERATE    1                                  112        208   21
130   GENERATE    1                                  132        575   58
210   GENERATE    1                                  212        22    2
* BLOCKS 4 THRU 214 ASSIGN ALL PARAMETERS TO TRANSACTIONS
* AND SIMULATES THE INPUT INTO THE SYSTEM
4     ASSIGN      1     FN1                          6
6     ASSIGN      3     FN11          BOTH           8          10
8     COMPARE     P1    E     K46                    12
10    ADVANCE                                        240
12    ASSIGN      4     FN11                         14
14    ASSIGN      6     FN20                         240
22    ASSIGN      1     FN2                          24
24    ASSIGN      3     FN12          ALL            26         29
26    COMPARE     P1    LE    K18                    30
27    COMPARE     P1    E     K25                    29
28    COMPARE     P1    LE    K46                    240
29    ASSIGN      4     FN11                         34
30    ASSIGN      4     FN12                         32
32    ASSIGN      6     FN21                         240
34    ASSIGN      6     FN21                         240
52    ASSIGN      1     FN3                          54
54    ASSIGN      3     FN13          ALL            56         58
56    COMPARE     P1    LE    K14                    240
57    COMPARE     P1    LE    K40                    60
58    ASSIGN      4     FN11                         66
60    ASSIGN      4     FN12          BOTH           62         63
62    COMPARE     P1    E     K17                    64
63    ASSIGN      6     FN20                         240
64    ASSIGN      6     FN21                         240
66    ASSIGN      6     FN20                         240
82    ASSIGN      1     FN4                          84
84    ASSIGN      3     FN14          BOTH           86         87
86    COMPARE     P1    LE    K11                    88
87    ASSIGN      4     FN13                         92
88    ASSIGN      4     FN12                         90
90    ASSIGN      6     FN21                         240
92    ASSIGN      6     FN21                         240
112   ASSIGN      1     FN5                          114
114   ASSIGN      3     FN15          ALL            115        117
115   COMPARE     P1    E     K32                    240
116   COMPARE     P1    LE    K47                    118
117   ADVANCE                                        240
118   ASSIGN      4     FN12                         120
120   ASSIGN      6     FN21                         240
132   ASSIGN      1     FN6                          134
134   ASSIGN      3     FN17          ALL            136        138
136   COMPARE     P1    E     K15                    140
137   COMPARE     P1    LE    K39                    142
138   ADVANCE                                        240
140   ASSIGN      2     K15                          250
142   ASSIGN      4     FN13                         144
144   ASSIGN      6     FN20                         240
```

```
152  ADVANCE                                          166          4000
154  ADVANCE                                          166          8000
156  ADVANCE                                          167          6000
158  ADVANCE                                          167          8000
162  SPLIT                                            164  181
164  SPLIT                                            168  169
166  ASSIGN    1     K21                              170
167  ASSIGN    1     K22                              171
168  ASSIGN    1     K52                              172
169  ASSIGN    1     K58                              173
170  ASSIGN    3     K1200                            240
171  ASSIGN    2     K20                              174
172  ASSIGN    3     K800                             596
173  ASSIGN    3     FN13                             240
174  ASSIGN    3     FN17                             176
176  ASSIGN    4     K500                             178
178  ASSIGN    6     FN20                             250
181  ASSIGN    1     K10                              182
182  ASSIGN    3     K800                             183
183  ASSIGN    2     K10                              184
184  SPLIT                                            596  250
190  GENERATE  1                                      192          400
192  SPLIT                                            194  195
194  ASSIGN    1     K20                              196
195  ASSIGN    1     K59                              198
196  ASSIGN    3     FN17                             250
198  ASSIGN    3     FN17                             620
212  ASSIGN    1     K62                              214
214  ASSIGN    3     FN14                             680
250  ADVANCE                              ALL          251  254
251  COMPARE   P1    LE    K30                        290
240  ASSIGN    2     K1                               250
290  ADVANCE                              .4           291  292
291  ADVANCE                              .666         300  301
292  QUEUE     3                                      345
596  SPLIT                                            597  598
597  SPLIT                                            506  507
598  SPLIT                                            508  509
* SENIOR PERSONNEL MANAGEMENT SPECIALIST
300  QUEUE     1                                      302
302  SEIZE     1                                      304
304  ADVANCE                                          306          *2
306  ADVANCE                              BOTH        308  309     *3
308  COMPARE   P3    GE    K1                         310
309  ADVANCE                                          310          *4
310  RELEASE   1                                      312
312  TABULATE  1                          BOTH        314  315
314  COMPARE   P2    GE    K1                         316
316  SPLIT                                            504  315
315  ADVANCE                              ALL         370  372
* PERSONNEL MANAGEMENT SPECIALIST
301  QUEUE     2                                      320
320  SEIZE     2                                      322
322  ADVANCE                                          324          *2
324  ADVANCE                              BOTH        326  327     *3
326  COMPARE   P3    GE    K1                         328
327  ADVANCE                                          328          *4
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 328 | RELEASE | 2 | | | | 330 | | |
| 330 | TABULATE | 2 | | | BOTH | 332 | 333 | |
| 332 | COMPARE | P2 | GE | K1 | | 334 | | |
| 333 | ADVANCE | | | | | 336 | | |
| 334 | SPLIT | | | | | 504 | 333 | |
| 336 | ASSIGN | 2 | K0 | | | 338 | | |
| 338 | ASSIGN | 3 | FN11 | | | 300 | | |
| * PERSONNEL MANAGEMENT SPECIALIST | | | | | | | | |
| 345 | SEIZE | 3 | | | | 346 | | |
| 346 | ADVANCE | | | | | 348 | | *2 |
| 348 | ADVANCE | | | | BOTH | 350 | 351 | *3 |
| 350 | COMPARE | P3 | GE | K1 | | 352 | | |
| 351 | ADVANCE | | | | | 352 | | *4 |
| 352 | RELEASE | 3 | | | | 354 | | |
| 354 | TABULATE | 3 | | | BOTH | 356 | 357 | |
| 356 | COMPARE | P2 | GE | K1 | | 358 | | |
| 357 | ADVANCE | | | | | 360 | | |
| 358 | SPLIT | | | | | 504 | 357 | |
| 360 | ASSIGN | 2 | K0 | | | 362 | | |
| 362 | ASSIGN | 3 | FN11 | | | 300 | | |
| 370 | COMPARE | P1 | LE | K15 | | 374 | | |
| 371 | COMPARE | P1 | LE | K22 | | 376 | | |
| 372 | TERMINATE | | | | | | | |
| 374 | SPLIT | | | | | 500 | 376 | |
| 376 | ADVANCE | | | | BOTH | 378 | 379 | |
| 378 | COMPARE | P6 | GE | K1 | | 470 | | |
| 379 | TERMINATE | | | | | | | |
| 470 | ADVANCE | | | | | 472 | | *6 |
| 472 | ASSIGN | 3 | K0 | | | 474 | | |
| 474 | ASSIGN | 6 | K0 | | | 250 | | |
| 252 | COMPARE | P1 | LE | K49 | | 400 | | |
| 400 | ADVANCE | | | | .666 | 401 | 402 | |
| * SENIOR PERSONNEL ACTIONS SPECIALIST | | | | | | | | |
| 401 | QUEUE | 4 | | | | 404 | | |
| 404 | SEIZE | 4 | | | | 406 | | |
| 406 | ADVANCE | | | | | 408 | | *2 |
| 408 | ADVANCE | | | | BOTH | 410 | 411 | *3 |
| 410 | COMPARE | P3 | GE | K1 | | 412 | | |
| 411 | ADVANCE | | | | | 412 | | *4 |
| 412 | RELEASE | 4 | | | | 414 | | |
| 414 | TABULATE | 4 | | | BOTH | 416 | 417 | |
| 416 | COMPARE | P2 | GE | K1 | | 418 | | |
| 417 | ADVANCE | | | | BOTH | 420 | 421 | |
| 418 | SPLIT | | | | | 504 | 417 | |
| 420 | COMPARE | P1 | E | K41 | | 422 | | |
| 421 | SPLIT | | | | | 422 | 500 | |
| 422 | ADVANCE | | | | BOTH | 424 | 425 | |
| 424 | COMPARE | P6 | GE | K1 | | 470 | | |
| 425 | TERMINATE | | | | | | | |
| * PERSONNEL ACTIONS SPECIALIST | | | | | | | | |
| 402 | QUEUE | 5 | | | | 440 | | |
| 440 | SEIZE | 5 | | | | 442 | | |
| 442 | ADVANCE | | | | | 444 | | *2 |
| 444 | ADVANCE | | | | BOTH | 446 | 447 | *3 |
| 446 | COMPARE | P3 | GE | K1 | | 448 | | |
| 447 | ADVANCE | | | | | 448 | | *4 |
| 448 | RELEASE | 5 | | | | 450 | | |

```
450  TABULATE   5                        BOTH  452  453
452  COMPARE    P2     GE     K1              454
453  ADVANCE                                 456
454  SPLIT                                   504  453
456  ASSIGN     2      KO                    458
458  ASSIGN     3      FN11                  401
504  ASSIGN     3      KO                    254
500  ASSIGN     3      FN11                  502
502  ASSIGN     2      KO                    254
253  COMPARE    P1     E      K53            260
254  ADVANCE                          PICK  506  509
* PERSONNEL RECORDS SPECIALIST
506  QUEUE      6                           510
510  SEIZE      6                           512
512  ADVANCE                                514       *2
514  ADVANCE                                516       *3
516  RELEASE    6                           518
518  TABULATE   6                           520
520  TERMINATE
* PERSONNEL RECORDS SPECIALIST
507  QUEUE      7                           530
530  SEIZE      7                           532
532  ADVANCE                                534       *2
534  ADVANCE                                536       *3
536  RELEASE    7                           538
538  TABULATE   7                           540
540  TERMINATE
* PERSONNEL RECORDS SPECIALIST
508  QUEUE      8                           550
550  SEIZE      8                           552
552  ADVANCE                                554       *2
554  ADVANCE                                556       *3
556  RELEASE    8                           558
558  TABULATE   8                           560
560  TERMINATE
* PERSONNEL RECORDS SPECIALIST
509  QUEUE      9                           570
570  SEIZE      9                           572
572  ADVANCE                                574       *2
574  ADVANCE                                576       *3
576  RELEASE    9                           578
578  TABULATE   9                           580
580  TERMINATE
260  PRIORITY   2                           261
261  SPLIT                                  262  263
262  SPLIT                                  510  530
263  SPLIT                                  550  570
* REPORTS SPECIALIST
620  ADVANCE                                621
621  QUEUE      10                          624
624  SEIZE      10                          626
626  ADVANCE                                628       *3
628  RELEASE    10                          630
630  TERMINATE
680  ADVANCE                          .5    681  682
* PROCESSING SPECIALIST
681  QUEUE      11                          684
```

```
682  QUEUE          12                694
684  SEIZE          11                686
686  ADVANCE                          688          *3
688  RELEASE        11                690
690  SPLIT                            500   692
692  TERMINATE
* PROCESSING SPECIALIST
694  SEIZE          12                696
696  ADVANCE                          698          *3
698  RELEASE        12                700
700  SPLIT                            500   692
```

# APPENDIX D

## COMPUTER COMPILATION OF SECOND INPUT SUBROUTINE

| LOC | NAME | X | Y | Z | SEL | NBA | NBB | MEAN | MOD | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | UCB | 3017413ET741 | | | | | | | | |
| * DATA 1 & 71 V | | | | | | | | | | |
| * FUNCTIONS 1 THRU 6 ASSIGN PARAMETER 1 TO ALL TRANSACTIONS | | | | | | | | | | |
| 1 | FUNCTION | RN1 | D4 | | | | | | | |
| .178 | 16 | .794 | 23 | .942 | 46 | 1.0 | 48 | | | |
| 2 | FUNCTION | RN1 | D9 | | | | | | | |
| .0066 | 4 | .0067 | 12 | .0068 | 13 | .0285 | 18 | .1434 | 25 | .1435 33 |
| .3485 | 34 | .98 | 41 | 1.0 | 49 | | | | | |
| 4 | FUNCTION | RN1 | D6 | | | | | | | |
| .07 | 3 | .43 | 9 | .4301 | 8 | .4302 | 11 | .4303 | 36 | 1.0 38 |
| 5 | FUNCTION | RN1 | D4 | | | | | | | |
| .7816 | 32 | .8496 | 37 | .9046 | 47 | 1.0 | 54 | | | |
| 6 | FUNCTION | RN1 | D4 | | | | | | | |
| .5266 | 15 | .6696 | 35 | .6876 | 39 | 1.0 | 53 | | | |
| * FUNCTIONS 11 THRU 21 ASSIGN ACTION TIMES TO ALL TRANSACTIONS | | | | | | | | | | |
| 11 | FUNCTION | RN1 | D5 | | | | | | | |
| .2 | 3 | .4 | 4 | .6 | 5 | .8 | 6 | 1.0 | 7 | |
| 12 | FUNCTION | RN1 | D5 | | | | | | | |
| .2 | 8 | .4 | 9 | .6 | 10 | .8 | 11 | 1.0 | 12 | |
| 13 | FUNCTION | RN1 | D11 | | | | | | | |
| .0909 | 10 | .1818 | 11 | .2727 | 12 | .3636 | 13 | .4545 | 14 | .5454 15 |
| .6363 | 16 | .7272 | 17 | .8181 | 18 | .9090 | 19 | 1.0 | 20 | |
| 14 | FUNCTION | RN1 | D11 | | | | | | | |
| .0909 | 25 | .1818 | 26 | .2727 | 27 | .3636 | 28 | .4545 | 29 | .5454 30 |
| .6363 | 31 | .7272 | 32 | .8181 | 33 | .9090 | 34 | 1.0 | 35 | |
| 15 | FUNCTION | RN1 | D21 | | | | | | | |
| .0476 | 36 | .0952 | 37 | .1425 | 38 | .1904 | 39 | .238 | 40 | .2857 41 |
| .3333 | 36 | .3809 | 37 | .4285 | 36 | .4761 | 39 | .5238 | 40 | .5714 41 |
| .619 | 42 | .6666 | 43 | .7142 | 44 | .7619 | 45 | .8095 | 46 | .8571 47 |
| .9047 | 48 | .9523 | 49 | 1.0 | 50 | | | | | |
| 17 | FUNCTION | RN1 | D25 | | | | | | | |
| .04 | 180 | .08 | 185 | .12 | 190 | .16 | 195 | .2 | 200 | .24 205 |
| .28 | 210 | .32 | 215 | .36 | 220 | .4 | 225 | .44 | 230 | .48 235 |
| .52 | 240 | .56 | 245 | .6 | 250 | .64 | 255 | .68 | 260 | .72 265 |
| .76 | 270 | .8 | 275 | .84 | 280 | .88 | 285 | .92 | 290 | .96 295 |
| 1.0 | 300 | | | | | | | | | |
| 20 | FUNCTION | RN1 | D9 | | | | | | | |
| .0625 | 2000 | .125 | 2200 | .1875 | 2400 | .25 | 2600 | .75 | 2800 | .8125 3000 |
| .875 | 3200 | .9375 | 3400 | 1.0 | 3600 | | | | | |
| 21 | FUNCTION | RN1 | D11 | | | | | | | |
| .05 | 10000 | .1 | 10400 | .15 | 10800 | .2 | 11200 | .25 | 11600 | .75 12000 |
| .8 | 12400 | .85 | 12800 | .9 | 13200 | .95 | 13600 | 1.0 | 14000 | |
| * FUNCTIONS 24 THRU 33 ASSIGN WAITING TIMES TO TRANSACTIONS BEFORE | | | | | | | | | | |
| * THEY ENTER THE SYSTEM | | | | | | | | | | |
| 24 | FUNCTION | RN1 | C2 | | | | | | | |
| 0 | 182 | 1.0 | 222 | | | | | | | |
| 25 | FUNCTION | RN1 | C2 | | | | | | | |
| 0 | 57 | 1.0 | 69 | | | | | | | |
| 26 | FUNCTION | RN1 | C2 | | | | | | | |
| 0 | 183 | 1.0 | 199 | | | | | | | |
| 27 | FUNCTION | RN1 | C2 | | | | | | | |
| 0 | 2279 | 1.0 | 2785 | | | | | | | |
| 28 | FUNCTION | RN1 | C2 | | | | | | | |

```
0       140    1.0     172
 29     FUNCTION        FN1     C2
0       398    1.0     426
 33     FUNCTION        FN1     C2
0       38     1.0     46
 1      VARIABLE        X1+FN24
 2      VARIABLE        X2+FN25
 3      VARIABLE        X3+FN26
 4      VARIABLE        X4+FN27
 5      VARIABLE        X5+FN28
 6      VARIABLE        X6+FN29
 7      VARIABLE        X7+K400
 8      VARIABLE        X8+FN33
 1      TABLE           P1      1       1       31
 2      TABLE           P1      1       1       31
 3      TABLE           P1      1       1       31
 4      TABLE           P1      31      1       19
 5      TABLE           P1      31      1       19
 6      TABLE           P1      1       1       63
 7      TABLE           P1      1       1       63
 8      TABLE           P1      1       1       63
 9      TABLE           P1      1       1       63
* GENERATORS 2,20,50,80,110,130,210 DETERMINE THE INPUT DATA
 1      GENERATE        39                      2
 20     GENERATE        126                     21
 50     GENERATE        44                      51
 80     GENERATE        3                       81
 110    GENERATE        51                      111
 130    GENERATE        18                      131
 210    GENERATE        190                     211
 2      ASSIGN  7       V1                      3
 3      SAVEX   1       P7                      4
 4      ASSIGN  1       FN1                     6
 6      ASSIGN  3       FN11            BOTH    8       10
 8      COMPARE P1      E       K46             12
 10     ADVANCE                                 16
 12     ASSIGN  4       FN11                    14
 14     ASSIGN  6       FN20                    16
 16     ADVANCE                                 240             *7
 21     ASSIGN  7       V2                      23
 22     ASSIGN  1       FN2                     24
 23     SAVEX   2       P7                      22
 24     ASSIGN  3       FN12            ALL     26      29
 26     COMPARE P1      LE      K18             30
 27     COMPARE P1      E       K25             29
 28     COMPARE P1      LE      K41             36
 29     ASSIGN  4       FN11                    34
 30     ASSIGN  4       FN12                    32
 32     ASSIGN  6       FN21                    36
 34     ASSIGN  6       FN21                    36
 36     ADVANCE                                 240             *7
 51     ASSIGN  7       V3                      53
 53     SAVEX   3       P7                      52
 52     ASSIGN  1       FN3                     54
 54     ASSIGN  3       FN13            ALL     56      58
 56     COMPARE P1      LE      K14             70
 57     COMPARE P1      LE      K40             60
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 59 | ASSIGN | 4 | FN11 | | | 66 | | | |
| 60 | ASSIGN | 4 | FN12 | | BOTH | 62 | 63 | | |
| 62 | COMPARE | P1 | E | K17 | | 64 | | | |
| 63 | ASSIGN | 6 | FN20 | | | 70 | | | |
| 64 | ASSIGN | 6 | FN21 | | | 70 | | | |
| 66 | ASSIGN | 6 | FN20 | | | 70 | | | |
| 70 | ADVANCE | | | | | 240 | | *7 | |
| 83 | SAVEX | 4 | P7 | | | 82 | | | |
| 81 | ASSIGN | 7 | V4 | | | 83 | | | |
| 82 | ASSIGN | 1 | FN4 | | | 84 | | | |
| 84 | ASSIGN | 3 | FN14 | | BOTH | 86 | 87 | | |
| 86 | COMPARE | P1 | LE | K11 | | 88 | | | |
| 87 | ASSIGN | 4 | FN13 | | | 92 | | | |
| 88 | ASSIGN | 4 | FN12 | | | 90 | | | |
| 90 | ASSIGN | 6 | FN21 | | | 94 | | | |
| 92 | ASSIGN | 6 | FN21 | | | 94 | | | |
| 94 | ADVANCE | | | | | 240 | | *7 | |
| 113 | SAVEX | 5 | P7 | | | 112 | | | |
| 111 | ASSIGN | 7 | V5 | | | 113 | | | |
| 112 | ASSIGN | 1 | FN5 | | | 114 | | | |
| 114 | ASSIGN | 3 | FN15 | | ALL | 115 | 117 | | |
| 115 | COMPARE | P1 | E | K32 | | 122 | | | |
| 116 | COMPARE | P1 | LE | K47 | | 118 | | | |
| 117 | ADVANCE | | | | | 122 | | | |
| 118 | ASSIGN | 4 | FN12 | | | 120 | | | |
| 120 | ASSIGN | 6 | FN21 | | | 122 | | | |
| 122 | ADVANCE | | | | | 240 | | *7 | |
| 131 | ASSIGN | 7 | V6 | | | 133 | | | |
| 133 | SAVEX | 6 | P7 | | | 132 | | | |
| 132 | ASSIGN | 1 | FN6 | | | 134 | | | |
| 134 | ASSIGN | 3 | FN17 | | ALL | 136 | 138 | | |
| 136 | COMPARE | P1 | E | K15 | | 140 | | | |
| 137 | COMPARE | P1 | LE | K39 | | 142 | | | |
| 138 | ADVANCE | | | | | 146 | | | |
| 140 | ASSIGN | 2 | K15 | | | 145 | | | |
| 142 | ASSIGN | 4 | FN13 | | | 144 | | | |
| 144 | ASSIGN | 6 | FN20 | | | 146 | | | |
| 145 | ADVANCE | | | | | 250 | | *7 | |
| 146 | ADVANCE | | | | | 240 | | *7 | |
| 190 | GENERATE | | 20 | | | 191 | | | |
| 191 | ASSIGN | 7 | V7 | | | 193 | | | |
| 193 | SAVEX | 7 | P7 | | | 192 | | | |
| 192 | SPLIT | | | | | 194 | 195 | | |
| 194 | ASSIGN | 1 | K20 | | | 196 | | | |
| 195 | ASSIGN | 1 | K39 | | | 198 | | | |
| 196 | ASSIGN | 3 | FN17 | | | 197 | | | |
| 197 | ADVANCE | | | | | 250 | | *7 | |
| 198 | ASSIGN | 3 | FN17 | | | 199 | | | |
| 199 | ADVANCE | | | | | 620 | | *7 | |
| 213 | SAVEX | 8 | P7 | | | 212 | | | |
| 211 | ASSIGN | 7 | V8 | | | 213 | | | |
| 212 | ASSIGN | 1 | K62 | | | 214 | | | |
| 214 | ASSIGN | 3 | FN14 | | | 215 | | | |
| 215 | ADVANCE | | | | | 680 | | *7 | |

# BIBLIOGRAPHY

## LITERATURE CITED


1. Chapanis, A., "Men, Machines and Models," American Psychologist, March 1961, Vol. 16, pp. 113-131.

2. Department of the Army, Adjutant General Support in Theaters of Operation, FM 12-2, January 1968.

3. _____, Division/Separate Brigade Adjutant General, FM 12-4, (Initial Draft Manuscript) July 1971.

4. _____, Inspector General Inspection Guide, TB IG-2, July 1964.

5. _____, Management System for Tables of Organization and Equipment, AR 310-31, May 1970.

6. _____, Manpower and Equipment Control, Organization and Equipment Authorization Tables-Personnel, AR 570-2, March 1971.

7. _____, Military Personnel Office Management and Administrative Procedures, DA Pam 600-8, August 1970.

8. Gibson, Francis L., A GPSS II Model of a Logistic Transportation Problem, A Masters Research Paper, Georgia Institute of Technology, March 1969.

9. Hicks, Charles B. and Place, Irene, Office Management, Boston: Allyn and Bacon, Inc., 1963.

10. Johnson H. Webster and Savage, William G., Administrative Office Management, Reading, Massachusetts: Addison-Wesley Publishing Co., 1968.

11. Littlefield, C. L. and Peterson, R. L., Modern Office Management, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1956.

12. Naylor, T. H., et al., Computer Simulation Techniques, New York: John Wiley and Son, Inc., 1966.

13. Quade, E. S., "Mathematics and Systems Analysis," Analysis for Military Decisions, Rand R 387-PR, November 1964.

14. Schmidt, J. W. and Taylor, R. E., Simulation and Analysis of Industrial Systems, Homewood, Illinois: Richard F. Irwin, Inc., 1970.

15. Teichrow, Daniel and Lubin, John F., "Computer Simulation-Discussion of Techniques and Comparison of Languages," Communications of the ACM, Vol. 9, October 1966.

16. UNIVAC, General Purpose Systems Simulator II, 1963.

17. U. S. Army Combat Developments Command, Personnel and Administrative Services Agency, Manpower Authorization Criteria for Personnel Direct-Workers (ACN 7801), Fort Benjamin Harrison, Indiana, 1966.

18. U. S. Army Infantry School, Personnel Handbook, Fort Benning, Georgia, 1969.

19. Vail, Robert, Military Applications of Dynamo, A Master's Research Paper, Georgia Institute of Technology, June 1968.

20. Weiner, M. G., "Gaming Methods and Applications," Analysis of Military Decisions, Rand R 387-PR, November 1964.

## OTHER REFERENCES

Argyris, Chris, Integrating the Individual and the Organization, New York: John Wiley and Son, 1964.

Blake, K. and Gordon, G., "Systems Simulation and Digital Computers," IBM Systems Journal, Vol. III, No. 1, 1964.

Chruden, Herbert J. and Sherman, Arthur W., Personnel Management, Cincinnati, Ohio: South-Western Publishing Co., 1968.

Cuming, Maurice W., The Theory and Practice of Personnel Management, London: Heineman, 1968.

Department of the Army, Division Support System: Organization and Procedures, AR 600-17, May 1969.

_____, Enlisted Military Occupational Specialties, AR 611-201 January 1967.

_____, Personnel Services Division, Organization and Procedure, AR 600-16 January 1964.

Efron, R. and Gordon G., "A General Purpose Digital Simulation and Examples of Its Applications," IBM Systems Journal, Vol. III, No. 7, 1964.

Fishman, G. S. "Problems in the Statistical Analysis of Simulation Experiments," Rand Memo 4880-PR, February 1966.

Flippo, Edwin B., Principles of Personnel Management, New York: McGraw-Hill, 1966.

Kiviat, Phillip J., "Development of New Digital Simulation Languages," Rand P 3348, April 1966.

Tocher, K., The Art of Simulation, Princeton, N. J.: Van Nostrand, 1964.